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Prickly Pear Experimental
=== Station, Dulacca. ===

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Reports up to 30th April, 1914.
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BY

Dr. Jean White,
Officer in Charge.

*(Reprint of Appendix IV. of Annual Reports of Department of
Public Lands for the Years 1912 and 1913.)*

Anthony James Cumming, Government Printer, Brisbane.

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Report of the Officer in Charge of the Prickly-Pear Experimental Station, Dulacca, up to 30th June, 1913.

Prickly-Pear Experimental Station,
Dulacca, 27th June, 1913.

To the Chairman of the Board of Advice on Prickly-Pear Destruction.

SIR,—I have the honour to submit the following report on the work done at the Prickly-Pear Experimental Station, Dulacca, up till 30th June, 1913.

In June, 1912, an area of 645 acres of pear-infested land in the parish of Dulacca, situated within a mile north-west from the railway station, was reserved for the site of the proposed Experimental Station.



Fig. 1.—Railway Tents in the Experimental Station Reserve.

I arrived in Dulacca on 18th July, 1912, when, with the exception of the clearing of a cart track and the pegging out of the sites for three railway tents in part of the reserved area, no steps had been taken towards the construction of the Experimental Station.

The building of the three tents was completed by 5th August, and one of the tents was used as a temporary laboratory. (Fig. 1.)

A triangular portion, including the north-west corner of the reserve and comprising about 85 acres, was portioned off for immediate use. Of this a small part (100 by 50 yards) was fenced in for a laboratory enclosure.

At the end of August a staff consisting of a foreman and three labourers was engaged, and the work of clearing the laboratory enclosure was commenced.

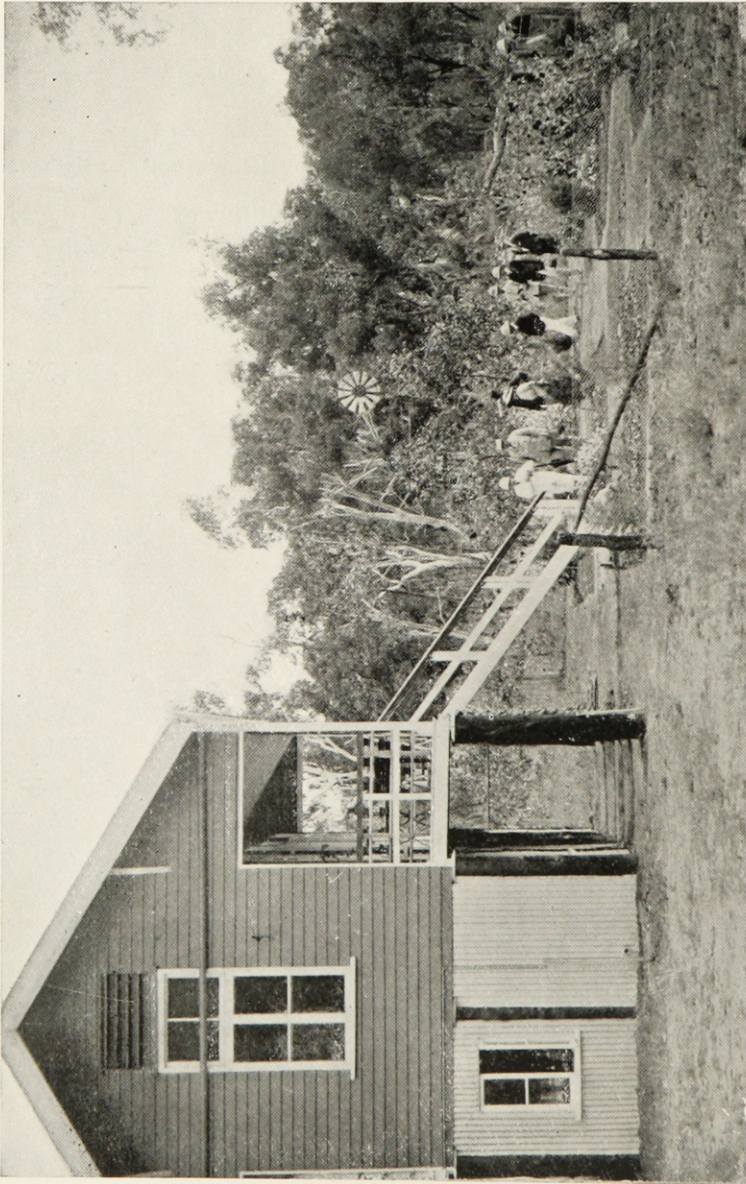


Fig 2.—Laboratory Building.

The laboratory buildings (Fig. 2) were finished during November, and the fencing of that part of the reserve which had been set apart for immediate use was completed by the beginning of the present year.

SUBDIVISION OF THE EXPERIMENTAL AREA.

The mode of subdivision of this area into experimental plots, &c., was decided upon, the eastern boundary being selected for testing the destructive effect of various chemicals when applied in different ways to the pear plants. Similarly the northern boundary was reserved for demonstrating the results of the other methods of destruction, such as the effect of phanerogamic parasites and lianes and of micro-organisms. A small area west of the laboratory enclosure was marked off into plots which were employed for the purpose of ascertaining the most advantageous position on the plant for the injection of poisons.



Fig. 3—Some of the Plots.

POISON PLOTS.

Each plot was made about four yards square and was separated from the adjacent plots by 2-ft. tracks, and tracks one yard in width were cut between the several lines of plots. (Fig. 3.)

The first systematic poisoning experiments were commenced on 20th September, 1912, this series being confined to the investigation of the best position for injection. The plots on the western side of the laboratory enclosure were utilised and were labelled with the letters of the alphabet.

Throughout this series of experiments the following poisonous mixture was employed, which was recommended by Mr. Brünnich, Chemist in the Department of Agriculture, and which will be subsequently referred to as Brünnich's arsenic mixture:—

Common salt, 15 lb.

Arsenic trioxide, 10 lb.

Caustic soda, 4 lb.

This mixture was applied as solid and liquid injections; in the latter case cold water was added to the powder till the whole volume measured eight gallons. The poison was injected into the so-called "bulbs," main trunks, old, medium, and young segments and green fruits, all the plants in each separate plot being subjected to the same mode of treatment.

Rather a small quantity of poison was put into each plant with the view, not of actually killing the plant, but of determining the relative efficiencies of equal small amounts of poison when injected into the different members of the plants. The experiments were performed in pairs. In the first plot, the poison was put into the centre of the part of the plant selected for injection, and in the second plot it was placed in two shallow pouches slit in the corresponding part of the plant just deep enough below the surface to sever the xylem vessels of the stele.

Each pair of experiments was carried out with both solid and liquid poisons, thus making a total of four plots in which the poison was injected into each part of the plant.

The condition of the seven most affected plots, noted on 2nd December, is enumerated in the following table, in which the plot containing the most injured plants is placed at the head of the list and so on in rotation. This order is maintained throughout the whole series of experiments:—

Name of Plot.	Position of Injection.	Quantity and Mode of Injection.	Comparative Effect of Poison.
V ..	Medium segment (surface)	10 c.c. liquid ..	Most affected plot.
P ..	Medium segment (centre) ..	10 c.c. liquid ..	Second affected plot.
I ..	Old Segment (surface) ..	3 c.c. powder	Third affected plot.
J ..	Medium segment (surface)	3 c.c. powder	Fourth affected plot.
D ..	Medium segment (centre) ..	10 c.c. liquid ..	Fifth affected plot.
M ..	" Bulb " (surface) ..	10 c.c. liquid ..	Sixth affected plot.
S ..	" Bulb " (centre) ..	10 c.c. liquid ..	Seventh affected plot.

Though the main plants in plots M and S were apparently dead, the effect of the "bulb" injections was to cause the collapse of the branches, which soon came to lie in contact with the ground. The nodes of some of these which touched the soil still possessed sufficient vitality to put out roots and shoots, thus producing new plants. Principally for this reason "bulb" injections cannot be regarded as satisfactory.

Reference to the above table shows that the plants in the four plots in which the poison had been injected into the medium-aged segments are included amongst those in the five most seriously affected plots. This demonstrates fairly conclusively that the most satisfactory results are obtained for spring and summer injections by injection into the medium-aged segments. A further set of experiments was performed for the purpose of ascertaining exactly into which segments of the plant the poisons should be injected in order to produce the maximum effect on the plant.

These plots were marked A, B, &c., and they were treated on 7th October, 1912, and the following summary is constructed from observations taken on 6th January, 1913:—

Name of Plot.	Position of Injection.	Quantity and Mode of Injection.	Comparative Effect of Poison.
L ₁ ..	3rd Segment (surface) ..	10 c.c. solution	Most affected plot.
G ₁ ..	2nd segment (centre) ..	10 c.c. solution	Second affected plot.
H ₁ ..	2nd segment (surface) ..	10 c.c. solution	3rd affected plot.
E ₁ ..	2nd segment (centre) ..	3 c.c. powder	4th affected plot.
P ₁ ..	4th segment (surface) ..	10 c.c. solution	5th affected plot.
C ₁ ..	1st segment (centre) ..	10 c.c. solution	6th affected plot.

The six least affected plots were as follows:—

Name of Plot.	Position of Injection.	Quantity and Mode of Injection.	Comparative Effect of Poison.
A ₁ ..	1st segment (centre) ..	3 c.c. powder	Least affected plot.
J ₁ ..	3rd segment (surface) ..	3 c.c. powder	2nd least affected plot.
M ₁ ..	4th segment (centre) ..	3 c.c. powder	3rd least affected plot.
O ₁ ..	4th segment (centre) ..	10 c.c. solution	4th least affected plot.
N ₁ ..	4th segment (surface) ..	3 c.c. powder	5th least affected plot.
F ₁ ..	2nd segment (surface) ..	3 c.c. powder	6th least affected plot.

The above shows that the plants in three plots out of four in which the injection was made into the second segment are included amongst the four plots whose plants were the most seriously injured; consequently, that part of the plant into which poison may in a general way be most effectively injected during spring and summer is the second segment from the free end of the branch. Additional experiments were carried out to further verify the above statement, and the results obtained in every instance were found to coincide with the above; whether the injection is made into the centre of the segment or into surface incisions does not appear to materially affect its efficiency. The results of several subsequent experiments carried out for the exclusive purpose of testing this point, however, seem to suggest that if any increased efficiency exists between these two modes of application, it is produced by the injection of the deleterious materials into the *centre* of the second segment. A set of experiments similar to the above is in progress, with the object of ascertaining whether, under winter conditions, the same results will be obtained.

Whilst all the experiments carried on at the Station are in progress records are taken daily at 9 a.m. of the mercurial barometer readings, maximum and minimum temperatures, rainfall, and wet and dry bulb readings.

DESTRUCTION BY MEANS OF POISONS.

Poison plots situated on the eastern boundary of the reserve.

The plots of the first row, of which there are 285, were treated with various chemicals in solid, liquid, and gaseous conditions, with the object of discovering which substances prove injurious to the prickly-pear plants, and which could be discarded as useless for this purpose. The reaction of the pear segments being fairly strongly acid seems to indicate that the acid poisons rather than the alkaline ones should prove more deleterious to the pear.



Fig. 4.—Plot sprayed with Phenol solution, half an hour after treatment

INJECTED PLOTS.

As in the case of the previously described plots, and for the same reason, only small quantities of poisons were employed.

SPRAYED PLOTS.

The plots were sprayed in pairs. The plants in one plot were left intact and in the other were chopped up fairly small, so as to expose the interior of the bulb and segments. Approximately, half a gallon of each solution was used per cwt. of pear plants. (Fig. 4.)

PLOTS TREATED WITH THE GASES OR VAPOURS.

The plants were covered by a tent in order to prevent the effect of the gas spreading to the adjacent plots. Those gases which are heavier than air were generated in a glass flask, raised on a platform outside the tent above the level of the tops of the plants.

The contents of the flask were heated by means of a spirit lamp, and the evolved gas passed through a tube leading from the mouth of the flask to the interior of the tent where it diffused among the plants. The gas was allowed to pass into the tent for about two hours in each case. (Fig. 5.)

In this report detailed results of the experiments are not stated. Only general lists of those substances which may be discarded on account of inefficiency and those which appreciably affect the plants in a greater or less degree are given. As far as possible every known plant poison and very many other chemicals have been employed so far regardless, within certain limits, of the cost of the materials. Those substances of which the action is still doubtful have not been included in either list.

MATERIALS MORE OR LESS INJURIOUS TO THE PEAR.

I. LINE OF PLOTS.

Injections.

Arsenic trioxide and mixtures and compounds containing it.
Barium chlorate.
Cattle dip (Little's).
Chloroform.
Copper sulphate (solid injection only).
Ferrous sulphate.
Formaldehyde.
Lysol.
Mercuric chloride.
Phenol.
Potassium chlorate.
Potassium cyanide.
Zinc chloride.
Zinc sulphate.

MATERIALS NOT INJURIOUS TO THE PEAR.

I. LINE OF PLOTS.

Injections

Ammonia.
Barium chloride.
Barium nitrate.
Boric acid.
Calcium oxide and sulphur.
A mixture of calcium oxide, calcium carbide, sodium carbonate, sodium chloride, and hydrochloric acid.
A mixture of calcium oxide, sodium carbonate, and sulphur.
Carbon bisulphide.
Ether.
Hydrochloric acid.
Lead arsenate.
Lead nitrate.
Lyttle's phenyle.
Magnesium sulphate.
Manganese chloride.
Methylated spirits.
Nitric acid.
Potassium chloride.
Potassium nitrate.
Pyrogallie acid.
Sodium biborate.
Sodium chloride.
Sodium hydroxide.
Sulphuric acid.
Turpentine.
Xylol.

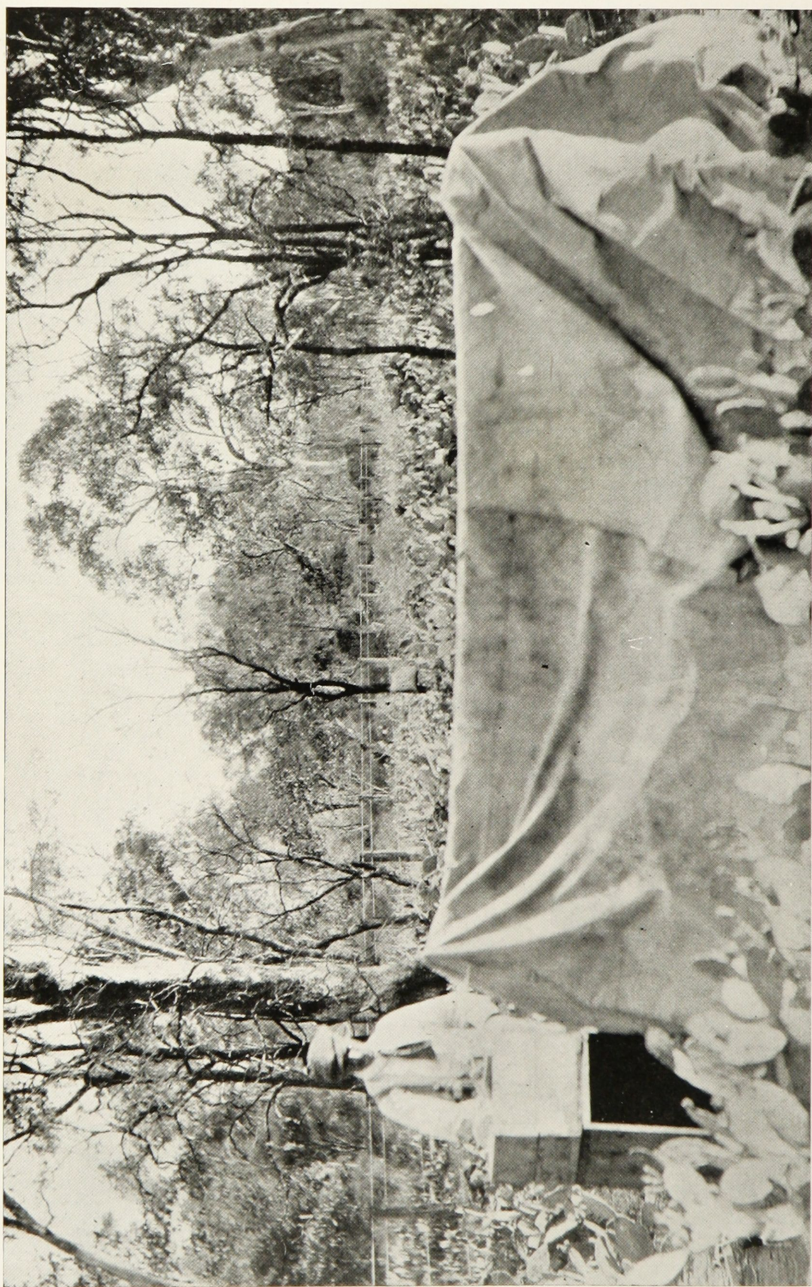


Fig. 5.—Method of Poisoning Pear by Gas.

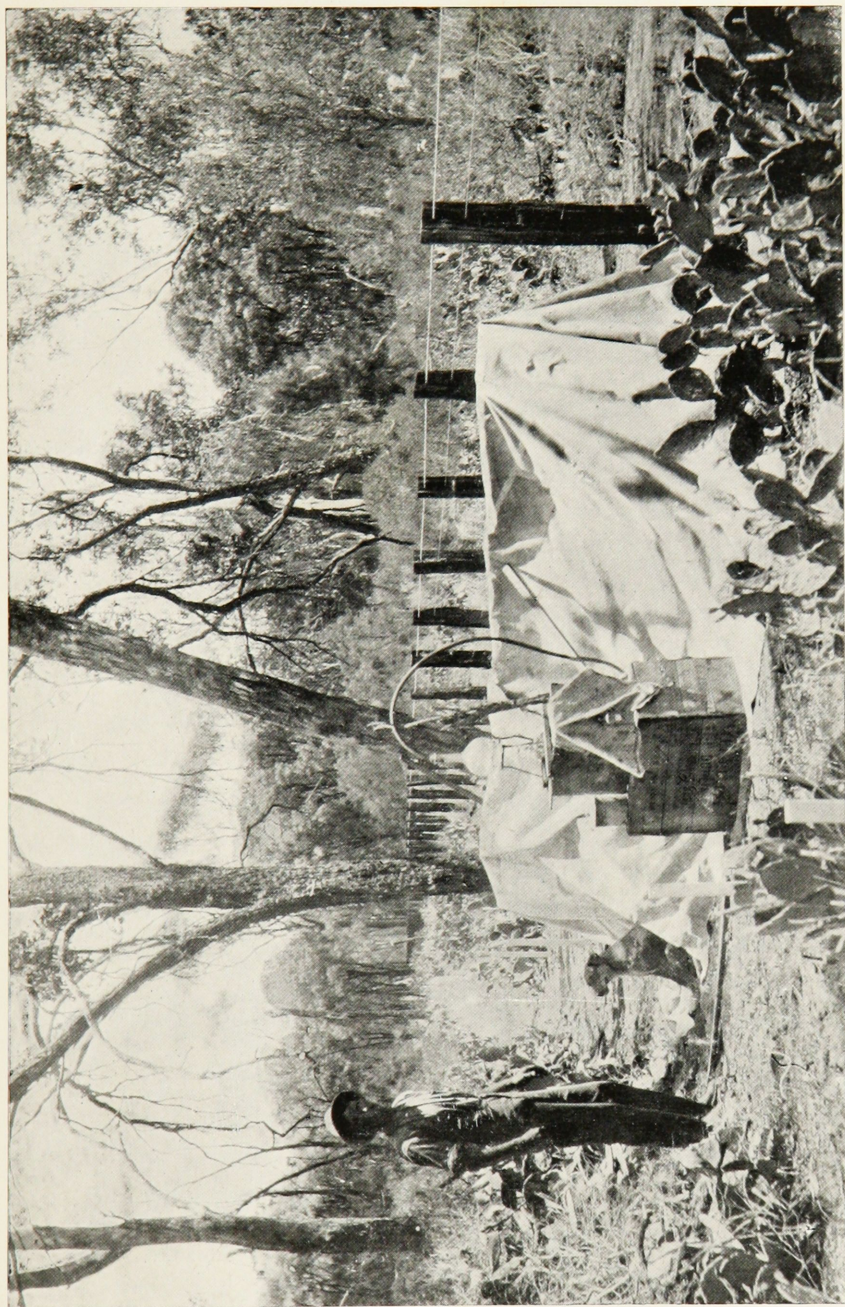


Fig. 5.—Method of Poisoning Pear by Gas

MATERIALS MORE OR LESS INJURIOUS TO

MATERIALS NOT INJURIOUS TO THE PEAR.

PEAR PLANTS.

I. LINE OF PLOTS.

I. LINE OF PLOTS.

Sprays.

Arsenic trioxide and mixtures and compounds containing it.
 Cattle dip (Little's).
 Chloroform.
 Mercuric chloride.
 Phenol.
 Sulphuric acid.
 Zinc chloride.

Sprays

Ammonia.
 Barium chloride.
 Barium nitrate.
 Bordeaux mixture.
 Boric acid.
 Calcium oxide and sulphur.
 A mixture of calcium oxide, calcium carbide, sodium carbonate, sodium chloride, and hydrochloric acid.
 A mixture of calcium oxide, sodium carbonate, and sulphur.
 Carbon bisulphide.
 Copper sulphate.
 Ether.
 Hydrochloric acid.
 Lead arsenate.
 Lead nitrate.
 Lyttle's phenyle.
 Magnesium sulphate.
 Methylated spirits.
 Nitric acid.
 Potassium chloride.
 Potassium nitrate.
 Pyrogallie acid.
 Sodium baborate.
 Sodium chloride.
 Sodium hydroxide.
 Turpentine.
 Xylol.
 Zinc sulphate.

MATERIALS MORE OR LESS INJURIOUS TO
THE PEAR.

MATERIALS NOT INJURIOUS TO THE PEAR.

I. LINE OF PLOTS.

I. LINE OF PLOTS.

*Gas or Vapour Charges.**Gas or Vapour Charges.*

Arsenic chloride.
 Arsenic trihydride.
 Chlorine.
 Mercuric chloride vapour.
 Sulphur dioxide.

Ammonia.
 Benzene vapour.
 Carbon bisulphide.
 Ether.
 Formaldehyde.
 Hydrochloric acid fumes.
 Hydrocyanic acid fumes.
 Hydrogen sulphide.
 Iodine vapour.
 Mercury vapour.
 Methylated spirit vapour.
 Nitric acid fumes.
 Nitrogen peroxide.
 Nitrous oxide.
 Phenol vapour.
 Turpentine vapour.

A certain proportion of the materials tested produce a marked effect on the pear very rapidly, especially in the injected plants, but within a short time the injected segments, together with the adjacent ones into which the poison has spread, drop off and leave the main plant apparently unaffected.

The plots of the second row, of which there are 264, were utilised for further testing the effects of those materials which had already been proved to be deleterious to the pear.

The quantities and compositions of these substances and mixtures were modified with the object of further weeding out the less injurious effective ones and the ultimate determination of the most satisfactory poisons and their minimal effective doses.

In addition, several not previously employed substances were tried. The injected plots were treated in two sets of four for each poison used, the plants in one set being injected with solids, those in the other set with concentrated solutions. In each set of plots each plant in one plot was subjected to a small dose of poison, applied to one part only, while in the next plot the same amount of poison was distributed among six segments in the same plant. A fairly large dose was given to each plant of the third and fourth plots, being administered in a similar manner to those in the first and second plots just mentioned. All the injections were applied to the centre of the second segments from the free end of the branch.

The sprayed plots were treated in sets of two pairs. The "bulb" of each plant in one plot of each pair was pierced once before spraying. One pair of plots was only sprayed once, while the other pair was subjected to a second spraying about four weeks after the first. Solutions of graduated strengths were employed for every material made use of.

The plots subjected to poisonous vapours were treated in pairs, the plants in one plot being treated once only, and those in the other plot were done a second time about four weeks later.

This particular series of experiments had to be continued on to the IV. line as 137 additional plots were required to complete the series.

The effects of the application of the various poisons to these plots are not sufficiently advanced at present to allow of the statement of any definite conclusions. The following further list of substances may, however, be discarded with safety as not being of any practical value in the problem of pear destruction:—

INEFFECTIVE POISONS. II. LINE OF PLOTS.

Injections.	Sprays.	Gas and Vapour Charges
Barium phenolate	Barium phenolate	Boric acid and 50% carbon dioxide Mercuric chloride vapour
Carbon bisulphide and methyl- ated spirits	Carbon bisulphide and methyl- ated spirits	
Copper hydrate and ammonia ..	Copper hydrate and ammonia	
Lead carbonate (solid injection only)	Lead carbonate and nitric acid	
Mercuric chloride (solid injection only)	Mercuric chloride and 1% methylated spirits	
Mercuric chloride and 1% methylated spirits	Mercuric chloride and 5% hydrochloric acid	
Mercuric chloride and 5% hydro- chloric acid	Mercuric chloride and 20% sulphuric acid	
Mercuric chloride and 20% sul- phuric acid	Phenol and 5% methylated spirits	
Phenol and 5% methylated spirits	Potassium phenolate	
Potassium phenolate	Sodium baborate and methyl- ated spirits	
Sodium baborate and methylated spirits		
Sodium phenolate		

INEFFECTIVE POISONS. IV. LINE OF PLOTS.

Arsenic trioxide, caustic soda and phenol	Lead acetate	Xylol
Cattle dip (Little's)	Picric acid	
Chloroform	Potassium chlorate and strong nitric acid	
Lead acetate	Sulphur and carbon bisulphide	
Potassium chlorate and nitric acid	Wood creosote	
Potassium sulphocyanide (solid injection only)		
Zinc chloride (solid injection) ..		
Zinc sulphate		

The object of the third line of poison plots is to ascertain whether the results following the application of poisons (acid, alkaline, and neutral) administered in a solid, liquid, or gaseous condition are materially influenced by the particular time of the year at which these poisons are applied.

The first set of these experiments was performed on 2nd January, 1913, and similar series are carried out at fortnightly intervals throughout the year.

Each series of experiments consists of ten plots, which are treated in the following manner:—

1. Solid injection of 6 c.c. of Brünnich's arsenic mixture per plant.
2. Solid injection of 6 c.c. of mercuric chloride powder per plant.
3. Liquid injection of 20 c.c. of Brünnich's arsenic mixture per plant.
4. Liquid injection of 20 c.c. of 50 per cent. hydrochloric acid per plant.
5. Liquid injection of 20 c.c. of 50 per cent. phenol in methylated spirits per plant.

6. Sprayed with an 8 per cent. solution of the concentrated solution used for plot 3. Half a gallon of solution to each approximate cwt. of pear.
7. Sprayed with an 11.5 per cent. hydrochloric acid solution. Half a gallon of solution per approximate cwt. of pear.
8. Sprayed with a 20 per cent. solution of phenol in methylated spirits. Half a gallon of solution per approximate cwt. of pear.
9. Charged for two hours with arsenic chloride gas.
10. Charged for two hours with hydrochloric acid fumes.

All the plots in all the lines are carefully examined and noted weekly.

After the great bulk of poisoning experiments has been performed, and the list of poisons has been reduced to a few efficient ones, steps will be taken to determine to what extent, if at all, the quality of the soil is deteriorated by the application of poisons to the plants. In order to do this a series of pairs of plots will be cleared, the first plot by means of poisons, the second by some method independent of their application. The plots of each pair will be sown with equal numbers of common agricultural seeds, and the numbers which germinate, and the degree of perfection attained by the plants, will be compared.

PASSAGE OF POISONS THROUGH THE PLANTS.

Series of experiments illustrating the course taken by poisonous substances through plants which have been subjected to injection, spraying, and gaseous treatment during the summer months have been carried out, and similar series will be performed during the winter.

COURSE THROUGH INJECTED PLANTS.

The first noticeable effect of the injection of poisonous substances is the rapid discolouration of the injected segments. After a varying period of time the adjacent segment, usually the one immediately below the injected segment, exhibits a white opacity in the region of the stele. This opacity more or less gradually extends to the other segments, and is generally followed by the drying or decay of the segments. The indicator employed for tracing the course of injected liquids through the pear plant was concentrated aqueous solution of eosin, which was injected into the centre of one segment in a living plant. The experiments were mostly done in pairs, in which one old and one young plant were selected growing near together and apparently under quite similar conditions. In every case a thermometer was suspended from the plant experimented on.

Twelve experiments were done on 15th October, 1912, of which only the general results are stated here.

Out of nine experiments carried out on young segments of young plants, in seven instances the solution travelled down at a greater rate than that at which it passed up. Out of thirteen experiments performed on fairly old segments of old plants—three on 15th October and ten on 27th November, 1912—the solution travelled downward in ten cases faster than it went upwards.

The average rates of the passage of the injected liquid up and down were as follows:—

Segments.				Rate of Upward Passage.	Rate of Downward Passage
Young	..	..	..	·175 cms. per min.	.. ·75 cms. per min.
Old	..	..	..	·220 cms. per min.	.. ·35 cms. per min.

With only one isolated exception out of a very large number of experiments performed, the rate of flow in both directions through the plant increased gradually and fairly regularly with rise of temperature.

COURSE OF POISONS THROUGH SPRAYED PLANTS.

In many instances of spraying with chemical solutions the plants throw out more or less rapidly over practically the whole of their surface a brownish, tough, protective layer, which gives the characteristic reactions of suberised tissue. The formation of this layer of cork is naturally detrimental to the passage of liquids or gases into the interior of the segment.

On 24th March, 1913, two special plots were sprayed, with the object of observing minutely the effect on the plants. One plot (labelled 5) was sprayed with a 10 per cent. solution of sodium hydroxide, the second (labelled 6) with Brünnich's arsenic solution coloured with red ink. The effects produced on the plants in these plots are tabulated as follows:—

Date.	Segments in Plot 5.	Segments in Plot 6.
24 March, 1913 ..	Sprayed with 10 per cent. solution of sodium hydroxide	Sprayed with Brünnich's arsenic spray solution coloured with red ink.
25 March, 1913 ..	The surfaces of the younger segments were conspicuously pitted. Each pit was shrunken and discoloured and near the centre was a single stoma or group of stomata through which the poison had entered. The poison was distinguishable in the mesophyll cells of these discoloured areas	The surfaces of the younger segments were similar in appearance to those of plot 5.
26 March, 1913 ..	The older segments were corky on the surface and the poison had only penetrated just below the surface. Light coloured irregular patches surrounded by dark areas were scattered over the younger segments. Removal of the epidermis showed that the mesophyll cells below the dark areas were disintegrated, while under the light areas they had practically disappeared, the tissue having shrunk in such a manner as to leave irregular fissures. (Fig. 6.)	The younger segments were spotted with discoloured patches, which were caused by decaying mesophyll cells below the surface. The coloured liquid could be traced through these cells into the spiral and annular vessels of the xylem.



Fig. 6—Stage in the Drying Process of a Segment.

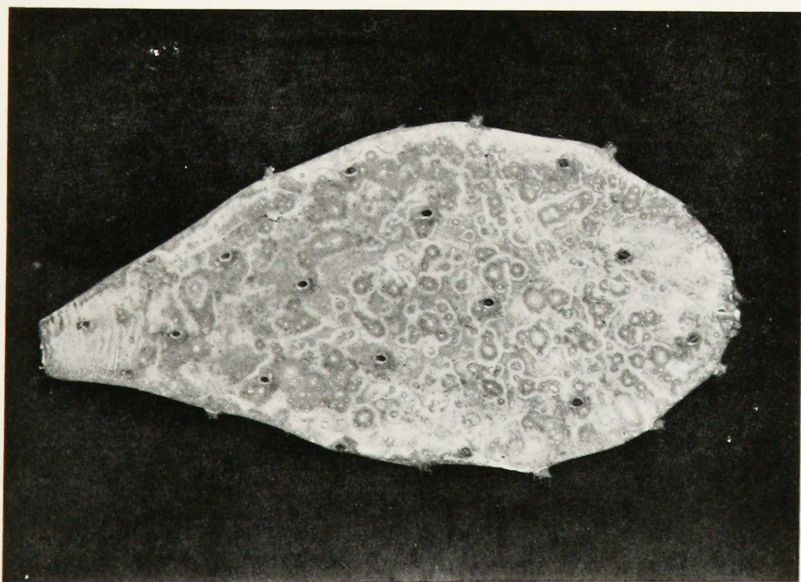


Fig. 7.—Young Segment a few days after treatment with Arsenic Chloride Gas.

Date.	Segments in Plot 5.	Segments in Plot 6.
27 March, 1913 ..	The younger segments had become very thin and withered and were rapidly drying up. Transverse section showed that to a certain limited extent the poison had penetrated into the stele and that from practically all the uninjured conducting tissues mucilaginous liquid oozed out freely, being present in much larger quantities than in segments of about the same stage taken from healthy unpoisoned plants.	The whole surfaces of the younger segments had become more or less discoloured and the epidermis extremely tough. Transverse section showed that the poison had penetrated into almost all the stelar vessels. The mucilaginous liquid was not particularly abundant in the conducting tissues.
31 March, 1913 ..	The younger segments had become very dry and reduced to tough epidermis, stelar tissue and a comparatively small amount of spongy cellular tissue. Very little mucilaginous liquid was visible.	The younger segments were exceedingly discoloured and the subdermal cells were rotting, being soft and mushy.
13 June, 1913 ..	The younger segments were completely dried up and the majority had fallen off the plants. The interior of the older segments and main trunks were still turgid and healthy and had thrown out many new segments.	The plants were apparently rotten right down to the bulbs and roots and there were no signs of the production of new segments up to the present date.

In addition to these two preceding very carefully noted experiments, all the spray experiments performed at the Station in a general way indicate that the result to be aimed at is the rotting of the plants, as illustrated by plot 6, rather than the drying of the plant, as illustrated by plot 5.

Apparently, while the plants are undergoing the drying process, the poison does not penetrate thoroughly into the conducting strands of the stele, so that its circulation through the plant is very limited.

Any nutrient material present in the segments is probably conducted away as quickly as possible by the uninjured conducting vessels to the cork-protected main stems and "bulbs," where it is stored in safety. The majority of the upper segments then break off from the plant by the formation of an abscission layer in a manner probably somewhat similar to the autumnal leaf fall in deciduous plants.

A peculiar feature sometimes noticed during the employment of sprays for the destruction of pear, and more particularly, though not exclusively, noticed during the use of acid spray materials, is that the first part of the sprayed segments to become affected is the small area immediately surrounding the nodes. These become discoloured and suberised, and readily peel off a few weeks after the plants have been sprayed. (Fig. 8.) As a rule, the discolouration gradually spreads over the internodes, though in some instances it is solely confined to these nodal areas. So far none of these affected nodes have been observed to produce sprouts, nor have they yet taken root in segments bearing them

planted in the reproduction plot at the Station. A large number of experiments dealing exclusively with this phenomenon is in process, and microscopic sections are being prepared which, by means of special methods of staining, will reveal the different stages in mitotic cell division, if such is occurring, and will thus denote the presence or absence of meristematic tissue below the affected cells. Such tissue, if present, would in all probability continue the vitality of the nodes.

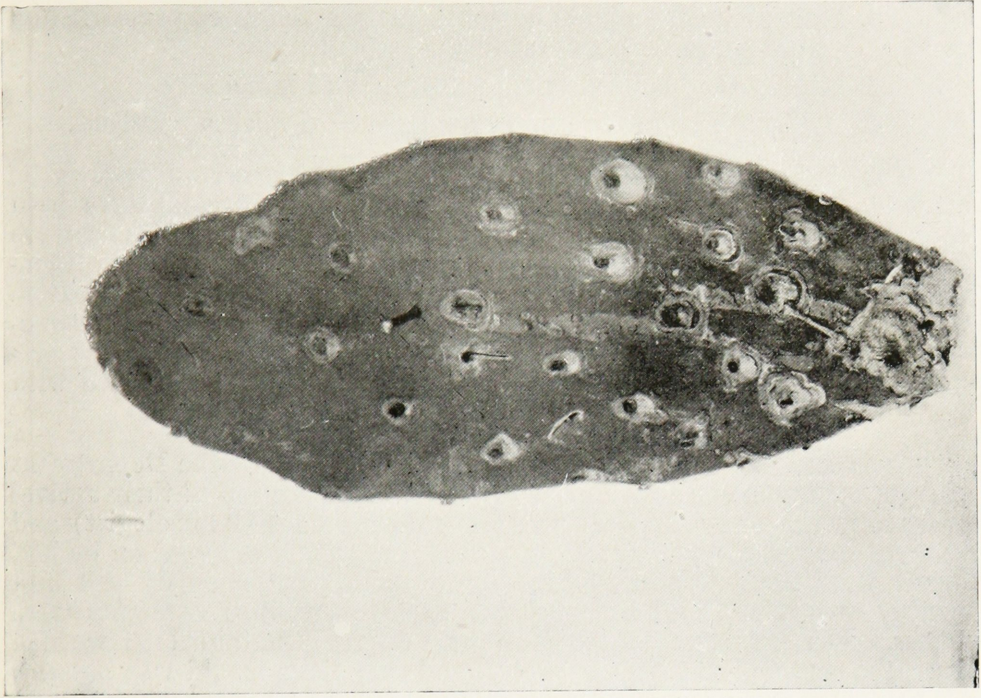


Fig. 8.—Segment with Nodal Areas affected after treatment with Sulphuric Acid.

COURSE OF GASEOUS POISONS THROUGH PLANTS.

The course taken by arsenic chloride gas has been observed in a plot in allotment 84 of the Experimental Station reserve treated on 3rd January, 1913, and also in the ordinary station experimental plots.

The general mode of action of the gas is apparently very similar to that of Brünnich's arsenic spray, and the passage through the plants seems to be almost identical with that of the same spray. (Fig. 7.)

Climatic conditions appear to influence the action of this poisonous gas in a marked degree, for though all the plants which were exposed to it at the station are very seriously injured, the effects up to date vary within broad limits. Some of the plants treated during the summer have undergone the drying process, and will probably sprout from the "bulb," while most of those treated during the autumn exhibit the most complete destruction yet obtained at the Station from the application of chemical poisons.

In connection with the production by the plant of a protective cork layer on the surface of the segments after these latter have been exposed to the action of poisons, a series of experiments has been started. These are not yet sufficiently advanced to furnish results of any value.

DESTRUCTION BY MEANS OF LIVING ORGANISMS.

Plots for testing this method of destruction have been prepared at the Experimental Station on the northern boundary of the fenced-in area.

The chief theoretical modes of destruction in this line can be enumerated under four heads:—

1. Smothering the pear plants by means of dense liane growth.
2. Destroying the plants by the injurious action of parasitic and semi-parasitic phanerogams.
3. Killing the plants through the agency of insects.
4. Killing the plants through the agency of micro-organisms.

The first, second, and fourth methods have received very little attention at the Station yet, but a large number of plots have been reserved along the northern boundary of the fenced-in area of the reserve for this purpose. The chairman of the Prickly-pear Travelling Commission of Inquiry forwarded to the Lands Department, Brisbane, from Matara, Ceylon, several boxes containing segments of *Opuntia monacantha*, which were infested with *Coccus indicus* (Green), and he also sent one box containing segments of *Nopalea cochinelifera* infested with another kind of wild cochineal insect.

The first consignment of these boxes was received by the Department of Agriculture on the 18th February, 1913, the condition of their arrival being reported on by Mr. Jarvis (Acting Government Entomologist) and by myself, respectively. The insect-infested segments reported on by Mr. Jarvis were packed in cardboard boxes, which were mostly wet and mouldy on arrival, and the majority of the contained segments were rotten. The segments reported on by me were contained in wooden cases, the contents of which were dry, and very little mould was present. All the older fully-developed segments were dry and powdery and very darkly coloured, being reduced merely to outer epidermis and vascular fibres. Some of the younger segments were still green though flaccid, and were fairly well infested with the insects. All the boxes of insects were brought to the Experimental Station, Dulacca, on 6th March, 1913. Fresh segments of *Opuntia monacantha* were produced from the vicinity of Brisbane, and of *Nopalea cochinelifera* from the Botanic Gardens, Sydney, and the garden of Mr. Milligan, in the Emerald district. On 13th March, these segments were placed in the boxes containing the insect-infested segments of *Opuntia monacantha* and *Nopalea cochinelifera*, respectively. A site for the erection of winter quarters for the insects had already been selected in the experimental station reserve, and a small area had been fenced in. In accordance with the advice received from the Travelling Commission, the erections were put up in form of three hessian tents. The framework of the tents was made of white-ant-proof timber and they were provided with well-fitting and well-secured wooden doors. The roofs were made slanting for the purpose of minimizing the quantity of rain which might enter the tents, and between the wire-netting fence and the tents a water-tight drain of tiles was laid down and kept always filled with extremely weak cyanide solution with a view of protecting the insects inside the tents from creeping insects which might prey upon them. To further reduce the possibility of trouble from this source, a fairly wide area of soil outside the fence was sprayed with cyanide solution and receptacles containing thick poisoned sugar solution were placed on the floor of the tents for several days before the admit-

tance of the wild cochineal insects into the tents. (Fig. 9.) Inside tent No. 3 were planted young healthy specimens of *Opuntia monacantha*;



Fig. 9.—Wild Cochineal Insects' Tents.

in tent No. 2 was left a large clump of plants of *Opuntia inermis* in many stages of growth; and in tent No. 1 young plants of *Nopalea cochinellifera* were planted.

On 28th April, all the contents of all the boxes were carefully examined, when it was found that with only a very few isolated exceptions all the segments sent from Ceylon were quite dead and reduced to membranous epidermis and woody fibres. (Fig. 11.)

The great majority of the insects in the boxes were apparently quite dead and still adhering to the crumbling dead segments, but in three of the wooden cases some of the live ones were found attached to the fresh green segments added to the boxes on 13th March. All the insects



Fig. 10.—Masses of Wild Cochineal Insects on a Segment of *Opuntia monacantha*

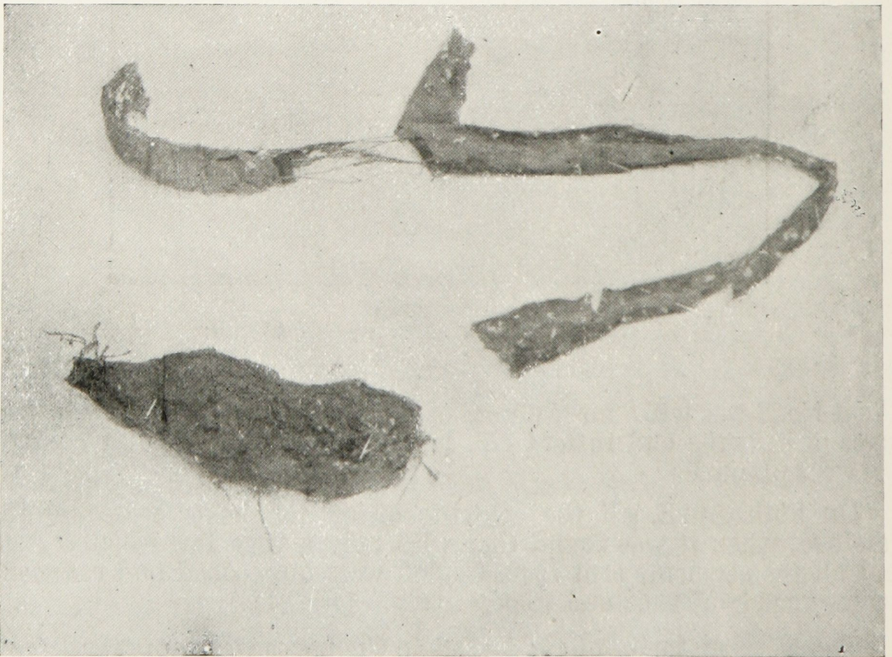


Fig. 11.—Segments of *Opuntia monacantha* from Ceylon which were attacked by Wild Cochineal Insects.

in the cardboard boxes, except one, appeared to be dead, as there were none on the fresh segments placed in the box in March, and in all probability this was the case. In the cardboard box containing the segments of *Nopalea cochinelifera* with its encysted specimens there were two encysted masses attached to the added green segments, and a few masses still attached to the dried segments which looked as if they might yet retain some vitality. The segments containing these masses were cut into small pieces, which were suspended by an *Opuntia* thorn from the young segments of the growing *Nopalea* plants in tent No. 1 in such a manner that the mass just came lightly in contact with the growing segments. A green segment fairly heavily infested with *Coccus indicus* was treated in the same manner, the insect mass being pinned on to the young segments of *Opuntia inermis* in tent No. 2 and of *Opuntia monacantha* in tent No. 3. A large supply of *Opuntia monacantha* was procured by the Prickly-pear Inspector, who kindly forwarded it to the Station. The contents of the boxes and tents were examined weekly, and the first change noted was that on 13th May, the insect masses in the three previously mentioned wooden cases containing *Opuntia monacantha* had increased considerably in size, though there was no sign of them on any of the new segments which had been put into the boxes on 28th April. (Fig. 10.) No further appreciable change was observed till 3rd June, when in the same three frequently mentioned wooden cases extremely minute brown specks were noticed on the green infested segments, which were mostly connected with the large parent masses by fine white threads of cottony encysting material. Several of these very small specks were just visible on the latest added segments, and with the hand lens they proved to be wild cochineal insects.

The insects placed in the tents were examined on 4th June. The masses pinned on to the plants growing in all the tents did not appear to be very healthy. In tent No. 1, containing *Nopalea* plants, there was one small insect attached to a growing segment. In tent No. 2, containing *Opuntia inermis*, several young cocci had become attached to the segments, and in tent No. 3, containing *Opuntia monacantha*, a fair number of young forms had established themselves on the growing segments. The same day two encysted masses were each enclosed in the centre of small nests of cocoanut fibre which were pinned to the segments of *Opuntia monacantha* in tent No. 3. On 24th June there was no appreciable change observable in the tents, but the insects in the three wooden boxes were reproducing quickly, and several young ones were adherent to some fresh segments of *Opuntia inermis* which were placed in the boxes twelve days previously.

If the wild cochineal insect can be successfully acclimatised in Queensland, it is of utmost importance to determine whether they would be likely to become parasitic upon any other varieties of plants, in which case it is possible that the "cure might prove worse than the disease."

A number of plots in the vicinity of the insect tents were cleared and prepared and sown with agricultural seeds. These plots are for the purpose of ascertaining whether, owing to the change of environment, the habits of the insects might become materially altered in such a manner that forms of vegetation other than the prickly-pear might serve as a source of food and a breeding-ground for them.

In order to be prepared for the advent and acclimatisation of further consignments of insects, &c., deleterious to the prickly-pear, which may be forwarded by the Travelling Commission, a structure is in process of erection in which will be grown all the different varieties of prickly-pear at present known in Queensland. This consists of an enclosure, twenty-one yards square, surrounded by a strongly built wall of galvanised iron in which is a door. The roof is composed of wire netting, covered with mosquito netting, supported by sapling posts. The interior is to be divided into plots, in each of which the different kinds of prickly-pear will be cultivated without any risk of its spreading. These plants will then be available for the harbouring of any parasites during their period of acclimatisation.

In response to requests that samples of diseased pear should be forwarded to the Experimental Station, four boxes of diseased specimens have been received from Roma district (two boxes), from Rockhampton district, and from Mungallala district.

Segments of normal healthy pear plants in the station reserve have been inoculated with material extracted from the diseased portion of these plants, but so far the results have all been negative. These segments have not been examined minutely for the presence of bacteria, as I have up to the present had no time available for bacteriological research.

ABNORMALITIES MET WITH IN OPUNTIA INERMIS.

A peculiar form of abnormality is extremely common in the Dulacca district, by which the abnormal plants produce fruits which are, almost without exception, sterile. The number of these abnormal plants compared with the normal ones in the vicinity of the Experimental Station is as follows:—

Five blocks, each five metres square, situated in Mr. Culliford's paddock, just outside the laboratory enclosure, were measured and the number of normal and abnormal plants counted.

	Normal Plants.					Abnormal Plants.		
1st block	..	..	..	..	7	..	3	
2nd block	..	..	..	..	6	..	9	
3rd block	..	..	..	..	6	..	2	
4th block	..	..	..	..	1	..	2	
5th block	..	..	..	..	4	..	8	
Total	..	..	..	..	24	..	24	

The number of abnormal and normal plants was counted in the first ten poison plots.

Plot.	Normal Plants.					Abnormal Plants.		
1	..	..	..	..	2	..	1	
2	..	..	..	..	3	..	2	
3	..	..	..	..	4	..	5	
4	..	..	..	..	6	..	2	
5	..	..	..	..	6	..	0	
6	..	..	..	..	6	..	0	
7	..	..	..	..	7	..	0	
8	..	..	..	..	4	..	5	
9	..	..	..	..	4	..	2	
10	..	..	..	..	2	..	1	
Total	..	..	..	..	44	..	18	

The preceding lists will serve to show how exceedingly common this type of abnormal pear is in this district. Presumably it is frequently met with in all the other *Opuntia inermis* infested districts. Isolated bushes of this abnormal pear were seen in the outskirts of the towns of Rockhampton and Emerald, but they were of much rarer occurrence in the parts of these localities visited than they are in Dulacca, and the abnormal plants in these former districts seemed less vigorous than they do here. It appears to be older and larger plants which exhibit the abnormal characters, and all the young plants which I have examined appear to be normal. This points to the probability of the abnormality being rather the effect of some external influence than of inherent qualities, and most of the very incomplete information collected up to the present seems to corroborate this statement. In some instances the normal and abnormal plants form distinct normal and abnormal clumps, but in many cases they grow so close together that they appear to be branches of the same plant. This, however, has been shown not to be the case in the very large number of observations made at the Experimental Station. Clumps composed of both normal and abnormal plants were dug up and the soil was carefully removed, and in every instance the abnormal branches could be traced to a bulb or bulbs quite distinct from those with which the normal branches were connected. Often these bulbs were so closely pressed together that it was only with the utmost care they could be separated without injury. The roots attached to the separate bulbs were all closely intertwined.

So far as my personal observations extend, I have found that the abnormal pear plants almost invariably occur in rather exposed localities, and I have not seen it growing under the dense brigalow scrub. Owing to the very common occurrence of this type of abnormality, the plants exhibiting it will be subsequently referred to as abnormal plants, and their composition and macroscopic structure will be later compared with those of the normal healthy plants.

POSSIBLE CAUSES OF THIS ABNORMALITY.

The cause is difficult to locate, and no positive evidence has been collected. Careful examination of all parts, including the roots, has not disclosed the presence of any macroscopic insect, &c. It has been suggested that the abnormality was caused by the burning of the plants through the agency of bush fires. Owing to the very close proximity which frequently exists between normal and abnormal plants, this theory seems hardly feasible. In order to test it, however, on 18th November, 1912, a small group of perfectly normal healthy-looking pear in the Station reserve was covered with dry grass and brushwood and severely scorched. This group was fenced off and labelled, and its development is being watched and noted.

That frosts are deleterious to the pear plants is evident from the rapidity with which their vigour becomes lessened, and from the fact that they become to a certain extent etiolated after a fairly light frost. To ascertain whether this condition could affect the plants to such an extent as to produce the abnormality, six normal healthy and particularly exposed plants have been marked and are observed at frequent intervals.

CLUB-LIKE ABNORMALITIES IN OPUNTIA INERMIS.

Fairly commonly, a larger or smaller branch of a plant, or less frequently an entire plant, has become metamorphised into a gall-like structure. These branches bear distorted segments and occasionally distorted fruits. Up to the present no attempt has been made to discover the cause of this form of distortion at the Experimental Station.

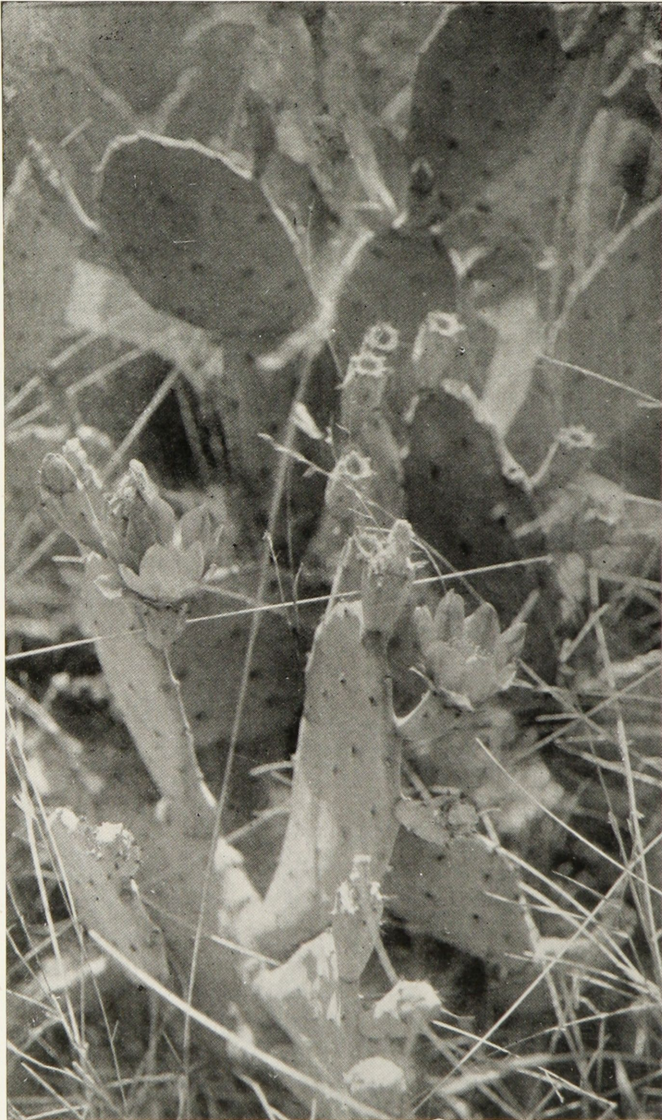


Fig. 12.—Normal Pear growing in the Experimental Station Reserve.

MACROSCOPIC STRUCTURE AND COMPOSITION OF OPUNTIA INERMIS.

An account of this species of prickly pear is published by Mr. J. H. Maiden in the *Agricultural Gazette* of New South Wales (Ag. Gaz., N.S.W., Vol. XXIII., pt. 8, August, 1912). The description given here is in the form of a comparison between the normal and abnormal

types. (Figs. 12 and 13.) On account of the sterility of the fruits borne by the latter type, it appears to me to be an important subject for investigation.



Fig. 13.—Abnormal Pear Growing in the Experimental Station Reserve.

ROOTS.

No apparent differences in macroscopic structure exist between the roots of the normal and abnormal pear. *Opuntia inermis* is a shallow-rooted plant. As a rule, the roots only penetrate to a depth of 15 to 20 cms. below the surface of the soil. Laterally they extend some considerable distance. The courses of two roots were traced from their origins to their apical extremities and they measured 2.36 and 4.55 metres respectively.

BULB.

This is the popular, but botanically incorrect, name applied to a swollen underground organ, which serves as a storehouse for reserve

foods and water. These organs are referred to by Schumann as “bulb-like swellings of the roots used as a storage for water.”

Sections of young “bulbs” treated with aqueous solution of iodine assume a dense blue colour, showing the presence of starch, the grains of which are almost round, and a few appear to be compound.

No macroscopic differences are distinguishable between the structure of the “bulbs” in normal and abnormal pear.

STEMS.

The hypocotyl is well developed, measuring from 5 to 12 millimetres in length, and the rootlets are given off abruptly.

The main stems in this species are mostly somewhat abbreviated and are covered with a corky periderm. Spines and glochidia project at intervals from their surface. The most numerous branches consist of flattened cladodes or segments, which are fleshy and generally green, and are provided with a fairly thick cuticle.

These segments differ to a slight extent in a few macroscopic details in normal and abnormal plants. The older segments of the abnormal plants are thicker and tougher than are those of the normal plants of presumably about the same age.

Several pairs of such segments were measured, and the average relative thicknesses are given below:—

Segment.	Normal Plants.	Abnormal Plants.
Young	·7 cms.	1·1 cms.
Medium aged	1·4 cms.	1·9 cms.

The older segments are generally covered externally with periderm, which is rather thick and peels off readily, and is usually coloured greyish-purple in abnormal and yellowish-brown in normal plants.

Nodes occur at intervals of from 3 to 5 cms. apart, and from them project tufts of soft woolly hairs, groups of glochidia, and sometimes a long sharp spine or spines.

LEAVES.

The cotyledons, of which there are normally two, are the most perfectly developed leaves in the plant. They are epigynous, green, and lanceolate, about 1 cm. in length, and generally pointed at the tip. Three cotyledons in one seedling is an abnormality of rather frequent occurrence.

The true foliage leaves are feebly developed and are very early deciduous. They are small and pointed and thin in texture, and in very young cladodes they cover the nodes. The leaves of normal and abnormal segments appear to be similar to each other. (Fig. 14.)

FLOWERS.

The flowers of the abnormal plants differ in a very marked degree from those of the normal plants. Out of hundreds of normal and abnormal plants in full bloom which were examined, only two instances



Fig. 14.—Very young Segments of *Opuntia inermis* with Foliage Leaves.

were met with of the occurrence of normal flowers on abnormal bushes, both of which were found on the same abnormal plant at the ends of chains of green fruits. (Fig. 17.)

The normal flowers are borne at the nodes of the segments and are fairly large, measuring about 8 cms. in diameter. The perianth segments are pale yellow in colour and are numerous and spirally arranged.

The stamens are indefinite and also spirally arranged, and the gynæcium consists of a large inferior ovary with a thick, fleshy style and much branched radiating stigma. At the base of the style is a pit-like structure forming a nectary which is surrounded by the staminal filaments.

The abnormal flowers present a considerable degree of variation in form, but typically the perianth is represented by two to six spiral turns of small, pointed, green bracts. In some flowers the stigma forms the most conspicuous structure, its radiating branches becoming green, flat, and leaflike. The stamens appear to be always conspicuous and very numerous, and in some specimens completely hide an inconspicuous stigma. The anthers are apparently functionless, no sign of pollen having been observed on them at any stages. The ovary is large and to external appearance perfectly developed, but removal of the perianth

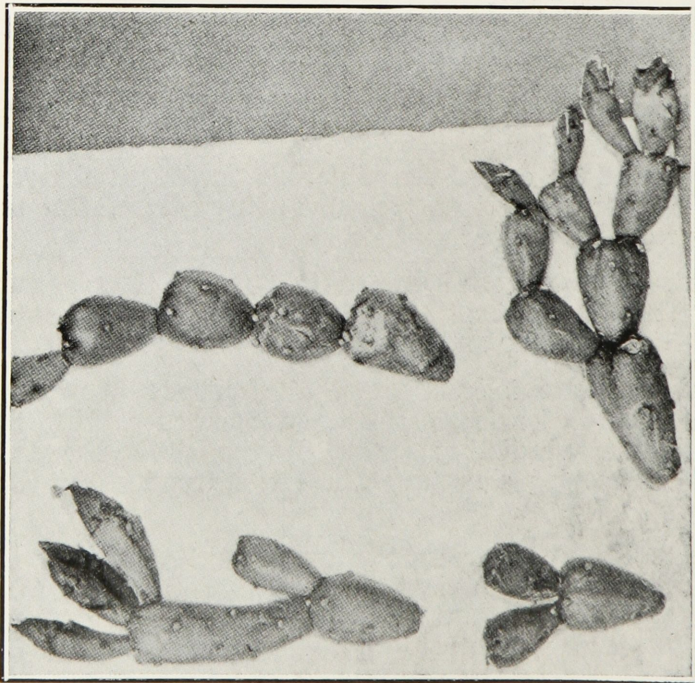


Fig. 15.—Chains of Unripe Abnormal Fruits and Flower Buds.

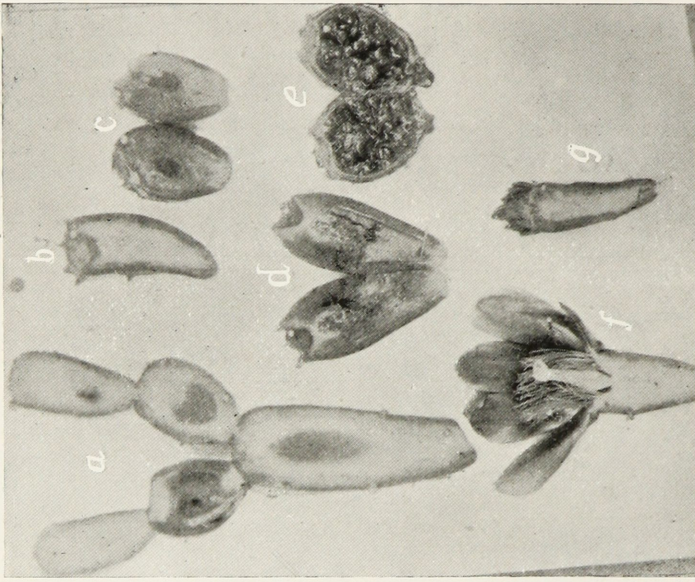


Fig. 16.—Abnormal and Normal "Fruits" and Flowers:—
a. Longitudinal section of abnormal chain, showing sterile "fruits."

- b. Longitudinal section of young normal fruit.
- c. Longitudinal section of young abnormal fruit.
- d. Longitudinal section of ripe abnormal fruit.
- e. Longitudinal section of ripe normal fruit.
- f. Longitudinal section of normal flower.
- g. Longitudinal section of abnormal flower.

segments shows that the projecting border which bears the andræcium is generally of larger diameter than the same border in the normal flowers, and the cup on the top of the ovary is shallower and less developed in the abnormal than in the normal flowers. The abnormal flowers are borne at the nodes of either the segments or green "fruits." Longitudinal section of the ovary shows that, as a general rule, traces of withered ovules are present, which rarely, if ever, become fertilised.



Fig. 17.—Abnormal Chain bearing Normal Flowers.

FRUIT.

The fruit is normally an inferior berry, which is of a rich carmine colour when ripe, and averages about 5.5 cms. in length and 3.15 cms. in breadth.

The term "fruit" should not be applied to the developed ovaries of the abnormal plants, which are usually solid throughout and do not contain fertilised seeds. Very frequently these pseudo-fruits form straight or branching chains, new "fruits" arising laterally or more rarely centrally from the nodes of the previously produced "fruits" of a chain. To a certain extent the abnormal fruits undergo ripening changes such as are experienced by the normal ones. From external appearance it is often a difficult matter to differentiate between the ripe normal and ripe abnormal "fruits." The abnormal ripe "fruits" are either quite solid throughout, without a vestige of seeds, or dried up unfertilised ovules may still be detected in the carpels. (Figs. 15 and 16.)

COMPOSITION OF NORMAL AND ABNORMAL PEAR.

The relative compositions of these two kinds of pear are shown below in tabulated form. All the analyses have been kindly done by Mr. Brünnich, of the Agricultural Department, Brisbane. Mr. Brünnich informs me that the following analyses were made from average samples of segments and fruits mixed:—

	Normal Pear.		Abnormal Pear.	
	Green Material.	Dry Material.	Green Material.	Dry Material
	%	%	%	%
Moisture	86.3	..	81.1	..
Dry matter ..	13.7	100.0	18.9	100.0
Containing—				
Nitrogen ..	.051	.382	.058	.315
Acidity (free) ..	..	1.26	..	.63
Total oxalic acid ..	..	.92	..	.97
Crude Ash ..	1.50	11.10	1.23	6.69
Containing—				
Silica	.033	.24	.049	.27
Iron oxide and Alumina ..	.037	.27	.066	.36
Lime	.454	3.36	.326	1.77
Magnesia ..	.164	1.22	.156	.84
Potash	.285	2.11	.306	1.66
Soda	.035	.26	.042	.23
Phosphoric acid ..	.031	.23	.037	.20
Sulphur trioxide ..	.016	.12	.015	.08
Chlorine ..	.048	.35	.034	.18

As the normal and abnormal plants grow so closely together, it is practically certain that the abnormality is not influenced in any appreciable degree by possible differences in the composition of the soils in which they grow. However, samples of soil collected from round the roots of a normal plant and of an abnormal plant have been analysed by Mr. Brünnich and a copy of his report is furnished below.

SOIL TAKEN FROM ROUND THE ROOTS OF NORMAL AND ABNORMAL PEAR.

Reaction.	Dulacca. Normal Pear. Acid.		Dulacca. Abnormal Pear. Acid.	
Moisture	6.60	..	5.46	..
Humus (humic acid, etc.)	1.40	..	2.05	..
Other organic matter and combin. water ..	.326	..	3.57	..
Total nitrogen N ₂	.123	..	.123	..

		Soluble in 1% Citric Acid.		Soluble in 1% Citric Acid.	
Soluble in HCl of 1.1 Sp. gr.	Phosphoric acid P ₂ O ₅ ..	.100	.0080	.205	.0062
	Lime CaO	.450	.112	.550	.100
	Magnesia MgO	.495	..	.562	..
	Potash K ₂ O	.285	.0040	.380	.0056
Insoluble in HCl of 1.1 Sp. gr.		78.81	..	79.09	..

Remarks.—There is not much difference between the two samples; the soil with abnormal growth is rather better than the soil with healthy growth.

Having noticed a fairly large tract of soil in the vicinity of the Miles Railway Station quite free from pear, I visited that district for the purpose of obtaining samples of this soil. These samples were forwarded to Mr. Brünnich for analysis, and a copy of his report is appended:—

SOIL TAKEN FROM MILES.

							Per cent.	Pounds per Acre 12" deep.
Moisture							·18 ..	..
Humus							·32 v. low	..
Other organic matter and combin. water							1·21 ..	..
Chlorine							·005 ..	..
Nitrogen							·070 low ..	2,450
Agricultural Analysis.	{ Soluble in hydro- chloric acid of 1·1 Sp. gr. }					Phosphoric acid P_2O_5 ..	·023 v. low	805
						Lime CaO	·115 low ..	4,025
						Magnesia MgO ..	·063 ..	..
						Potash K_2O	·251 v. fair	8,785
						Insoluble in hydrochloric acid of 1·1 Sp. gr. ..		
Readily Available Plant Foods.	{ Soluble in 1 per cent citric acid solution }					Phosphoric acid P_2O_5 ..	·0011 v. low	39
						Lime CaO	·0176 v. low	616
						Potash K_2O	·0061 fair	214

Remarks.—An extremely poor soil, containing, however, a fair amount of potash.

REPRODUCTION OF *OPUNTIA INERMIS*.

Great importance is attached to the methods of reproduction on account of the alarming rapidity with which it spreads. Consequently, experiments are being carried on at the Experimental Station for the investigation and enumeration of the different processes of reproduction—both vegetative and sexual. (Figs. 18 and 19.)

VEGETATIVE REPRODUCTION.

A special plot was prepared for demonstrating the vegetative reproduction in this pear. The following “cuttings” were planted in this plot on 16th November, 1912:—

- | | |
|---------------------------------------|-------------------------------|
| a. 3 normal flowers | f. 3 ripe abnormal fruits |
| b. 3 abnormal flowers | g. 3 old normal segments |
| c. 3 unripe normal fruits | h. 3 old abnormal segments |
| d. 3 chains of unripe abnormal fruits | i. 3 young normal segments |
| e. 3 ripe normal fruits | j. 3 young abnormal segments. |

The behaviour of these “cuttings” was observed and noted at least once a week.

The following list enumerates the results of these observations, and

also furnishes an indication of the relative times taken for the different "cuttings" to become established as independent pear plants:—

Date.	Specimen.	Condition of Specimen.
25th November	d. e. f. g. h. i. j.	One short root developed Drying up rapidly Drying up rapidly Slightly shrivelled Slightly shrivelled Curved and one short root developed in one Curved and one short root developed in one
9th December	a. b. c. f.	Completely dried up Drying up Completely dried up Completely dried up except one
16th December	d.	A second root developed
30th December	i. j.	A strong root developed. A strong root developed
6th January, 1913 ..	d. g. h.	All the chains had developed strong roots Dried up and shrivelled Dried up and shrivelled
13th January	b.	One ovary rooted
10th March	b. c. d. g. h. i. j.	All three green ovaries rooted All three specimens rooted A new segment developed from a node Completely dried up Almost completely dried up Growing well Growing well
23rd June	b. d. h.	Two fruits have developed new segments Three chains developed new segments Completely dried up.

Additional cuttings have lately been added to this plot.

SEXUAL REPRODUCTION.

Macroscopic structure of the seeds of Opuntia inermis.—The seeds are almost circular; the seed coat is hard and pale yellow in colour. The seed coat is comparatively thick, measuring about .8 m.m., except in one spot in the vicinity of the radicle, where it is considerably thinner and measures only about .38 m.m. The embryo is curved, dicotyledonous, and exalbuminous. (Fig. 20.)

Analysis of Prickly-pear Seeds.				Analysis of Prickly-pear Seeds.			
		%	%		%	%	
Moisture	2.47	..	..	Sol. carbohydrates ..	9.00	..	..
Total dry matter ..	..	97.53	..	Crude fat	7.12	..	..
Total proteids ..	4.65	..	..	Starch, chlorophyll, etc., by difference	11.62	..	..
Soluble proteids ..	..	..	13	Crude ash	3.29	..	..
Woody fibre (König)	39.77	..	..	Total nitrogen ..	..	80	..
Pentosans	22.08	..	..				

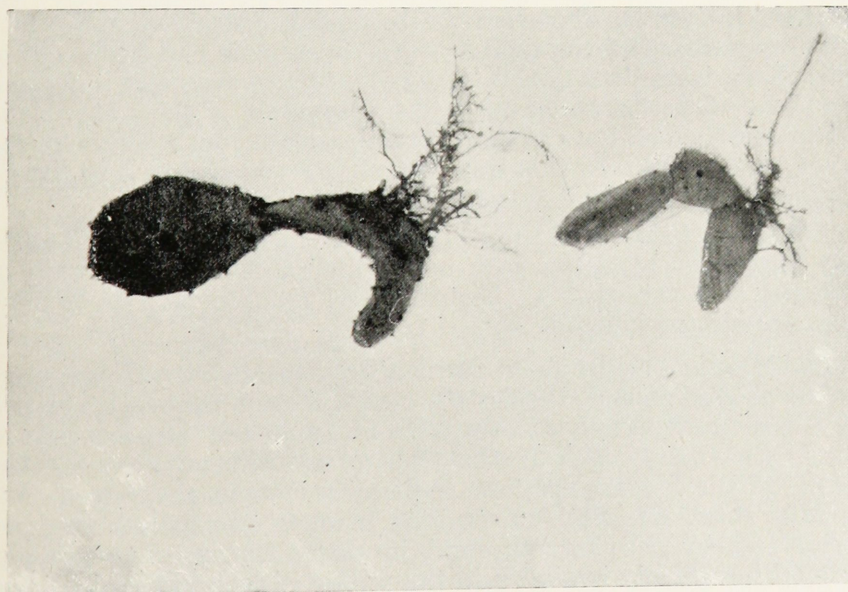


Fig. 18.—Young Plant produced vegetatively from a
Segment of *Opuntia inermis*.

Fig. 19.—Young Plant produced vegetatively from a
Green Fruit of *Opuntia inermis*.



Fig. 20.—Seedlings of *Opuntia inermis*.

I have been informed from many sources that the seeds of *Opuntia inermis* are incapable of germination unless they have passed through the digestive tracts of herbivora or birds, or have been subjected to other unusual external influences, such as bush fires, &c.

It is a well-established fact that with many seeds, including those of a large number of indigenous Australian plants, this is actually the case. Such seeds are designated "hard seeds," and they possess a well-developed impermeable cuticle on their external surface.

In order to prove or disprove the accuracy of this statement when applied to the seeds of *Opuntia inermis*, attention was first directed to the determination of the composition of the seed coat.

A hundred seeds were removed from freshly-ripened pear fruits, and these were well dried. They were put into a vessel of water, and in two days 100 per cent. had swelled. This phenomenon in itself strongly negated the suggestion of the existence of such an impermeable cuticle.

Sections were cut of the hard seed coat, and by means of various methods of staining it was found that there was no sign of any cuticle nor of cuticularised cells, but that it is composed wholly of sclerenchymatous prosenchyma lined internally with a delicate brown membrane. As lignified tissue allows water to permeate through it, the composition of the seed coat would account for the readiness with which the seeds swelled in water.

There is no doubt, however, that, though these cannot be termed "hard seeds," they belong to that class of seeds which exhibit "delayed germination," for fifty seeds sowed in the reproduction plot on 25th November, 1912, and fifty more sown in a box half-full of carefully sifted soil on 28th May, 1913, up to the present show no sign of germinating. There is no indication that the process of germination is hastened by the scorching of the seeds, for seeds which had been slightly burnt before being sown in the reproduction plot have not sprouted so far. Dr. Rothera, of the University of Melbourne, has kindly translated and copied for me the composition of the digestive juices in birds and herbivora as far as they have been determined. As soon as the necessary materials have been obtained, seeds will be exposed to the action of these artificially made juices, after which they will be sown in boxes along with untreated seeds to act as controls. In this way any effects which might be caused by the action of the digestive enzymes will be determined.

Practically all sections of the work are yet in an incompleted state, and many important branches have been untouched solely for want of time. I hope, however, with the help of Mr. Eva, to be able to start these branches almost immediately.

Invaluable assistance has been furnished by some of the Government Departments of Queensland, besides the Lands Department, more especially the Government Analyst's Department and the Department of Agricultural Chemistry; also by the Melbourne University, among the members of which I may mention Professor Ewart, Dr. Green, Mr. O'Brien, Miss Rees, Dr. Rothera, and Dr. Sweet, who have helped me with advice and by copying out, and in many instances translating, literature which was only available in the public libraries at Sydney and Melbourne.

I have, &c.,

JEAN WHITE.

Officer in Charge of the Prickly-pear Experimental Station, Dulacca.

Report of the Officer in Charge of the Prickly-Pear Experimental Station, Dulacca, from 1st July, 1913, to 30th April, 1914.

Prickly-Pear Experimental Station,

Dulacca, 30 April, 1914.

To the Chairman of the Board of Advice on Prickly-Pear Destruction.

SIR,—I have the honour to submit the following report on the work done at the Prickly-Pear Experimental Station, Dulacca, between 1st July, 1913, and 30th April, 1914.

The operations have been confined almost exclusively to two channels of investigation: (1) the observation of the effects of various chemical substances applied to the pear plants by different methods; (2) the acclimatisation and propagation of the wild cochineal insects forwarded to Queensland from Ceylon and South Africa by the Prickly-Pear Travelling Commission.

POISONING EXPERIMENTS.

The construction of experimental plots, for the purpose of ascertaining the relative values of different chemical specifics, was proceeded with in a similar manner to that in which they were prepared last year, and described in my previous report.

There are at present at the station between 1,800 and 1,900 experimental plots under treatment, situated in rows, altogether representing about 8 miles in length. Each plot is carefully constructed prior to treatment in the following manner:—All the undergrowth, seedlings, fallen segments, and fruits of pear are removed, by which means the plot is left quite clear of everything except the individual plants to be experimented on.

This cleaning up process has met with adverse criticism from some of the numerous visitors to the Station, who contend that the poisoning should be done under the natural conditions of growth of the pear. The reason for the clearing is, that once the plants in the plots have been subjected to treatment, they are left absolutely undisturbed, so that any segments, green fruits, or portions of pear on the soil have almost certainly become detached from the poisoned plants, and must be themselves more or less affected. The number of these fallen segments and unripe fruits which retain sufficient vitality to sprout and form new plants is noted at intervals. This investigation is considered of importance on account of the fact that the primary effect produced by many poisons is to cause the shedding of the affected segments and fruits, whilst other poisons do not cause this phenomenon, or do so in a much less pronounced degree. It is natural that poisons applied to the plants under the above favourable conditions, in which they are given free access to all parts of separate plants, will exert their maximum injurious effects on the pear. Consequently, any substances or mixture of substances in

the various proportions used at the Station, which do not produce any marked noxious effects on the pear in the cleared plots, may be safely discarded as useless. Any substances or mixture of substances which affect the plants to any considerable extent in the cleared plots are tried a second time on plants growing under their normal conditions in uncleared plots situated in quite a different locality in the experimental reserve, and the effects noted and compared with the plants which had been similarly treated in the prepared plots. The measurement and weighing of the different substances employed are performed with great accuracy, and samples of all the mixtures used are preserved in carefully corked and labelled bottles. These samples can be analysed, if necessary, in order to check the veracity of the data. In all the more recent experiments, for every plot poisoned there is a duplicate one treated as nearly as possible in exactly the same manner.

When the aerial parts of the plants have become quite dry, those in the duplicate plots will be burnt, in order to ascertain whether any of the substances used render the plant more readily combustible than other substances employed. The poisoning experiments have been solely confined to the Dulacca pest pear. All the specifics used are mixed, measured, and applied under the personal supervision of the first assistant.

In my previous report lists were published of chemical substances and mixtures which up to 30th June, 1913, had been proved to be deleterious or non-deleterious to the pear. Any chemicals included in the former list have been further tried, in addition to a large number of other substances which had not up to that date been employed at the station for pear eradication. As far as possible the pear-destructive powers possessed by every substance which can be procured, and which is not so expensive as to be useless from a commercial standpoint, has been or will be tested at the experimental stations.

DETERMINATION OF THE BEST POSITION FOR THE INJECTION OF POISONS INTO PRICKLY-PEAR PLANTS.

The results of a series of experiments performed during the summer months, with the object of ascertaining the most suitable position in plants of Dulacca pear for the injection of poisons, were enumerated in my last report.*

The results of a similar set of experiments performed during the winter months are appended below. The specific employed throughout the series was Brünnich's arsenical mixture, consisting of the following components and ingredients:—

Common salt, 15 lb.

Caustic soda, 4 lb.

Arsenic trioxide, 10 lb.

For liquid injection 8 gallons and for sprays 100 gallons of water were added to the above. The plots constructed for this series were adjacent to those employed during the summer for the same object, and they were treated on 9th June, 1913, the same method of treatment as in

* Annual Report of Department of Public Lands, Queensland, for the year 1912, page 66.

the previous series being maintained throughout the investigation.* The final readings were taken on 15th April, 1914. The plots containing the most injured plants are placed at the top of the list, and so on in order.

The position of the segment is considered relative to the top segment of a branch, which is designated the first segment.

Position of Injection.	Quantity and Mode of Injection.			Comparative Effect of Poison.
Second segment (centre) ..	3 c.c. powder	..	..	Most affected.
First segment (pouches) ..	3 c.c. powder	..	..	Second most affected.
Second segment (pouches) ..	10 c.c. liquid	..	..	Third most affected.
Second segment (centre) ..	10 c.c. liquid	..	..	Fourth most affected.
First segment (centre) ..	10 c.c. liquid	..	..	Fifth most affected.
Second segment (pouches) ..	3 c.c. powder	..	..	Sixth most affected.
First segment (pouches) ..	10 c.c. liquid	..	..	Seventh most affected.

The above table shows that the total number (four experiments) performed on the second segments from the top of a branch are included in the seven plots which received the greatest amount of injury from the poison injected. These results coincide to such an extent with those obtained from the experiments carried out during the summer months as to show conclusively that the best results are obtained when the injection is introduced into the younger segments, more especially into the second segments of the plants.

DESTRUCTION OF PRICKLY PEAR BY MEANS OF POISONS.

Injected Plots.—The position of the injections of poisons has been almost entirely confined to the centre of the second segments in each plant, the number of segments injected per plant in each plot ranging between one and six. The quantities of poisons injected into the plants of different plots also vary between fairly wide limits. By employing this method the minimum number of injections per plant, and the smallest quantities of different poisons required for the total destruction of the pear plants, will be ultimately determined.

The method of procedure adopted for the injections of poisons is as follows:—The upper edge of the segment is slit open by means of a butcher's knife, and in the case of powder injections the quantity of poison required is measured in a small spoon of a known capacity, the volume of liquids being measured in a small glass measuring-tube. The construction of an apparatus for the injection of small measured quantities of poisons, in a less crude manner than the above, will be considered when the most effective injections, powder and liquid, have been finally determined.

Sprayed Plots.—Since the publication of my last report all the sprayed mixtures have been applied to standing pear, chopping to expose the interior of the "bulb" to the action of the poison having been discarded as too expensive to be practicable.

Before any spraying is done, all the adjacent plants are completely covered with hessian, to prevent their becoming contaminated with poisons employed for the other plots.

All the spray materials tested have been used in different degrees of dilution, 5 per cent., 4 per cent., and 2 per cent. solutions being those most commonly employed. Of these solutions, either .5 gallons or .25 gallons

* Annual Report, Department Public Lands, Queensland, for the year 1912, page 66.

have been applied per approximate cwt. of pear, and in some instances the "bulb" of each plant has been pierced once before treatment. The deleterious effect produced on the pear plants by a second spraying, similar in every way to the first, but applied four weeks later, has been investigated, but the advantage gained by this procedure is not, apparently, sufficient to justify the extra expense involved in labour and the purchase of poisons. (Plate 1.)



PLATE 1.—Plants of Dulacca Pear three months after one spraying with 2·5 per cent. solution of arsenic pentoxide.

Plots Treated with Gases or Vapours.—The method employed throughout these experiments is practically identical with that described in my former report,* except that the canvas tents previously used to

* Annual Report, Department Public Lands, Queensland, for the year 1912, page 68.

cover the plants in the plot under treatment have been replaced by an iron tank, the reason for this change being that the fumes evolved caused the canvas to perish so quickly that it became necessary to consider the question of expense. In addition, the iron tank forms a more efficient protection for the other plots from the vapours given off under the tank. It is evident that in plants exposed to these fumes under the tank the injurious action of the fumes will be considerably greater than it is when the plants are uncovered and growing under their ordinary conditions. Accordingly any gases or vapours which are found not to appreciably affect the pear, when concentrated among the plants under cover, are thrown out of consideration as useless. When the fumes of any gases or vapours which are thus condensed round the plants are found to be destructive in a marked degree, they are tried again, being evolved amongst plants under their natural conditions situated in isolated parts of the station reserve where the above precautions are unnecessary. Several organic substances and every inorganic substance which it was possible to obtain, which were not an exorbitant price, were not spontaneously inflammable or explosive, whose specific gravity exceeds that of air, and whose boiling point is not above 200° C., have been tried in gaseous form at the station for the destruction of prickly-pear. Almost all have yielded purely negative results, even when the gas was concentrated round the plants by the tank.

The substances included in the following lists have been proved destructive, or non-destructive to pear up till the present date, and are supplementary to those published in my last report:—

MATERIALS MORE OR LESS INJURIOUS TO
PRICKLY PEAR (*OPUNTIA INERMIS*).

Solid Injections.

Arsenic pentoxide.
Arsenic trioxide.
Arsenic trioxide, caustic soda, and
chloride of lime.
Arsenic trioxide, caustic soda, and
potassium cyanide.
Arsenic trioxide, caustic soda, and salt.
Arsenic trioxide, caustic soda, and salt-
petre.
Arsenic trioxide and salt.
Arsenic trioxide and washing soda.
Arsenic trioxide, washing soda, and salt.
Copper sulphate.
Mercuric oxycyanate.
Phosphorus (yellow).
Potassium bichromate.
Sodium caco-dylate.
Sodium chlorate.
Sodium sulphite.

MATERIALS NOT INJURIOUS TO PRICKLY
PEAR (*OPUNTIA INERMIS*).

Solid Injections.

Aluminium sulphate.
Ammonium phosphate.
Ammonium sulphide.
Antimony oxide.
Arsenic sulphide.
Arsenic trioxide, caustic soda, and
sodium bisulphite.
Calcium fluoride.
Copper acetate.
Copper arsenate.
Ferric carbonate.
Ferric chloride.
Ferric oxide.
Ferrous chloride.
Ferrous oxide.
Ferrous sulphate.
Nickel sulphate.
Potassium cyanide.
Potassium ferro-cyanide.
Potassium permanganate.
Potassium sulphite.
Sodium phosphate.
Sodium sulphate.
Stannous chloride.
Strychnine.
Zinc chloride.

MATERIALS MORE OR LESS INJURIOUS TO
PRICKLY PEAR—*continued.*

Liquid Injections.

Antimony chloride.
Arsenic pentoxide.
Arsenic sulphide and caustic soda.
Arsenic trichloride.
Arsenic trioxide, ammonium hydroxide.
Arsenic trioxide and caustic soda.
Arsenic trioxide, caustic soda, and coal tar.
Arsenic trioxide, caustic soda, and chloride of lime.
Arsenic trioxide, caustic soda, and potassium cyanide.
Arsenic trioxide, caustic soda, and salt.
Arsenic trioxide, caustic soda, and salt-petre.
Arsenic trioxide and hydrochloric acid.
Arsenic trioxide and salt.
Arsenic trioxide, salt, and sulphuric acid.
Arsenic trioxide and washing soda.
Arsenic trioxide, washing soda, and salt.
Barium chlorate.
Cacodylic acid.
Mercuric oxycyanate.
Potassium sulphocyanide.
Sodium arsenite, salt, lime, and sulphur.
Sodium caco-dylate.
Sodium chlorate.

Vapours and Gases.

Arsenic trichloride.
Arsenic trioxide.
Arsenic trioxide and sulphur dioxide
(applied separately and simultaneously to the same plants).

MATERIALS NOT INJURIOUS TO PRICKLY
PEAR—*continued.*

Liquid Injections.

Aluminium sulphate.
Ammonium phosphate.
Ammonium sulphide.
Antimony oxide and caustic potash.
Arsenic trioxide.
Arsenic trioxide, caustic soda, and prickly-pear juice.
Arsenic trioxide, caustic soda, and sodium bisulphite.
Arsenic trioxide, washing soda, and sodium bisulphite.
Arsenic trioxide, salt, sodium bisulphite, and sulphuric acid.
Calcium fluoride and hydrochloric acid.
Copper acetate.
Ferric carbonate and hydrochloric acid.
Ferric oxide and hydrochloric acid.
Ferrous chloride.
Ferrous oxide.
Ferrous sulphate.
Kerosene.
Lead oxide, and caustic soda.
Lead oxide, caustic soda, and saltpetre.
Mercuric chloride and hydrochloric acid (in all proportions).
Mercuric chloride and methylated spirits (in all proportions).
Mercuric chloride and sulphuric acid (in all proportions).
Potassium bichromate.
Potassium chlorate.
Potassium cyanide.
Potassium ferro-cyanide.
Potassium permanganate.
Potassium sulphite.
Sodium phosphate.
Sodium sulphate.
Stannous chloride.
Sulphuric acid.
Tannin (from brigalow bark).
Zinc chloride.

Vapours and Gases.

Acetic acid.
Antimony hydride.
Arsenic fluoride.
Arsenic hydride.
Bromine.
Carbon dioxide.
Carbon tetrachloride.
Chlorine.
Cyanogen.
Hydrobromic acid.
Hydriodic acid.
Hydrogen peroxide.
Mercuric chloride.
Nitrous oxide.
Nitrosyl chloride.
Phosphine.
Pyrophosphoric acid.
Silicon fluoride.
Sulphur dioxide.

MATERIALS MORE OR LESS INJURIOUS TO
PRICKLY PEAR—*continued.*

Sprays.

Antimony chloride.
Arsenic pentoxide.
Arsenic sulphide and caustic soda.
Arsenic trichloride and hydrochloric acid.
Arsenic trichloride and methylated spirits.
Arsenic trioxide.
Arsenic trioxide and ammonium hydroxide.
Arsenic trioxide and caustic soda.
Arsenic trioxide, caustic soda, and carbolic acid.
Arsenic trioxide, caustic soda, and chloride of lime.
Arsenic trioxide, caustic soda, and potassium cyanide.
Arsenic trioxide, caustic soda, and salt.
Arsenic trioxide, caustic soda, and saltpetre.
Arsenic trioxide and salt.
Arsenic trioxide, salt, and sulphuric acid.
Arsenic trioxide and washing soda.
Arsenic trioxide, washing soda, and salt.

MATERIALS NOT INJURIOUS TO PRICKLY
PEAR—*continued.*

Sprays.

Aluminium sulphate.
Ammonium sulphide.
Antimony oxide and caustic potash.
Arsenic trioxide and hydrochloric acid.
Arsenic trioxide and potassium chlorate.
Arsenic trioxide, caustic soda, and prickly-pear juice.
Arsenic trioxide, caustic soda, and sodium bisulphite.
Arsenic trioxide, washing soda, and sodium bisulphite.
Arsenic trioxide, salt, sulphuric acid, and sodium bisulphite.
Barium chlorate.
Calcium fluoride and hydrochloric acid.
Copper arsenate.
Ferric carbonate.
Ferric chloride.
Ferrous chloride.
Ferrous oxide and hydrochloric acid.
Lead oxide and caustic soda.
Mercuric chloride and hydrochloric acid (in all proportions).
Mercuric chloride and methylated spirits (in all proportions).
Mercuric chloride and sulphuric acid (in all proportions).
Nickel sulphate.
Potassium bichromate.
Potassium ferro-cyanide.
Potassium permanganate.
Potassium sulphide.
Potassium sulphite.
Sodium phosphate.
Sodium sulphate.
Stannous chloride.
Strontium carbonate.
Strontium nitrate.
Sulphuric acid.
Tannin (from brigalow bark) solution.

In addition to the abovementioned substances and mixtures, other materials are in process of investigation, but the experiments have not proceeded far enough up to the present date to warrant their inclusion in the lists of either the effective or non-effective materials.

Following out a suggestion which was communicated to me by the secretary of the Prickly-Pear Board of Advice, two plots were treated in the following manner:—

A large quantity of sawdust, after having been thoroughly dried in a hot-air oven, was well mixed with 1 lb. of saltpetre, and the mixture ignited at the base of a clump of prickly-pear with the view of destroying it by combustion. No more permanent harm was done to the plants, however, than a slight singeing of the external skin of the segments.

A comparative table constructed in order of the most complete efficiency of different poisons, whether applied in the form of solid or liquid injections, sprays, or gas charges, cannot be published at this stage, as additional series of more delicate tests dealing with all the effective substances are in progress at the Station, and some time must elapse before a table can be constructed accurately enough to be final. These, in

conjunction with detailed quantitative lists, will be published in a subsequent report. Extremely promising results have been furnished by some of the specifics, more especially those injected into the plants. The determination of the minimum number of injections per plant, and the minimum dose which will prove fatal to large, medium, and small plants is in process of investigation at the present time. Close observation of the plots poisoned with various chemicals appears to emphasise the importance of the power of penetration possessed by the destructive agent. It is this property which is, in all probability, responsible for the frequently observed phenomenon, that a less actively poisonous salt may prove more efficacious for pear destruction than a more highly poisonous salt of the same substance.

EFFECT ON THE DIFFERENT PLANT ORGANS OF POISONS APPLIED TO PRICKLY-PEAR PLANTS.

Effect on Segments.—As mentioned in my last report,* the application of poisonous chemicals to the segments of the plants may affect them in one or more of three ways:—

(1.) The segments exposed to the action of the poison may dry up and become detached from the plants, after any useful nutrient material has been conducted away from them in the vessels of the stele, and deposited in the cork-covered lower and older parts of the plants.

(2.) The rapid formation of an impenetrable layer of cork prevents the entrance of more poisons into the segments, and thus protects the internal soft green tissue. If the quantity of poison which enters the segments prior to the formation of the cork is sufficient to cause the complete destruction of the segments, they wither more or less gradually, and finally fall off. As a general rule, however, the amount of poison which enters the segments immediately on its application to the plant is not sufficiently large to entirely destroy it, in which case the rotting or drying process does not extend throughout the entire segment, but produces patches of decayed tissue. As soon as the plant has recovered sufficiently from the first shock caused by the unusual chemical stimulus, new segments become budded off from the nodes situated in the unaffected portion of the segments, and the vitality of the plant is soon renewed. One single uninjured node on an otherwise destroyed segment is capable of sprouting, and forming the basis of a new branch.

(3.) The segments of the plant may become completely rotten throughout. In the problem of the pear destruction, this is the desired condition, and it depends largely on the previously mentioned power of penetration of the poisons. Usually, when rotting takes place, the poison percolates rapidly through the cells of the segments into the circulatory system, the cork-forming cells being themselves destroyed before they have a chance of active division and the subsequent development of suberised cells.

The rapid circulation of this penetrating substance through the stellar vessels of the plant generally effects the ultimate destruction of the older tough segments and "bulbs."

In order to determine accurately what actual quantity of poison enters a segment of a plant, either directly through the surface or by

* Annual Report of Department of Public Lands, Queensland, for the year 1912, p. 71.

means of the vascular mechanism, in sufficient strength to kill it, eight segments were removed from sprayed plots and forwarded to the Government Analyst, Brisbane, for analysis. Two segments were sent from each plant, one of which had become dry after rotting, the other being still soft and disintegrating. These segments were taken from plots treated as follows:—

1. Plot sprayed on 27th March, 1914, with a 5 per cent. solution of arsenic pentoxide (prepared by Merck). Half a gallon spray applied per approximate cwt. of pear.
2. Plot sprayed on 7th April, 1914, with a 1.87 per cent. solution of arsenic pentoxide (prepared by Government Analyst). Half a gallon spray applied per approximate cwt. of pear.
3. Plot sprayed on 27th March, 1914, with 1.5 per cent. solution of arsenic trioxide. Half a gallon of spray applied per approximate cwt. of pear.
4. Plot sprayed on 27th March, 1914, with Brünnich's arsenical spray mixture. Half a gallon of spray applied per approximate cwt. of pear.

Grains Present as Arsenic per pound of Prickly-pear Segments Analysed.

				Dry Substance.			Green Plant.	
Plot 1 ..	..	..	..	4.6	..	..	..	0.7
Plot 2	..	..	..	3.5	..	..	..	0.5
Plot 3 ..	..	..	..	0.8	..	..	..	0.1
Plot 4 ..	..	..	..	0.7	..	..	..	0.1

Effect on "Bulbs" and Main Stems.—These organs are usually well protected by a strongly developed cork layer, and it seems most probable that the decay and ultimate destruction of their component cells after the application of sprays or vapours is due rather to the conduction of the poisons to them through the stellar vessels than to the direct entrance of the poisons into them from the exterior.

Effect on the Production of Flowers.—As the flowers represent the sexual organs of the plant, the check or otherwise caused to their production by the previous application of poisonous specifics to the plant has been carefully noted during the flowering season of 1913.

The effects are only considered in those plants which had been subjected to treatment three months at least prior to flowering.

In the majority of instances, the poisoning of the plants exerts a check to flower production which may in a large measure be due simply to the fact that the younger segments of the plant, which bear the bulk of the flowers, have been destroyed by the action of the poison, and the new shoots are not sufficiently advanced during their first season to produce them.

In those plots in which the spraying was preceded by slashing of the plants to expose the interior of the "bulbs," the production of flowers was almost without exception absolutely checked, the check being observed whether the poisoning action on the plant was pronounced or not, so that the cause must be for the most part mechanical.

On this account, plants treated under the above conditions are omitted from the lists:—

Flowering absolutely Checked during the Season 1913 in Plants Poisoned by—

1. Arsenic trichloride (vapour).
2. Arsenic trioxide, caustic soda, and coal tar (injection and a fairly strong spray).
3. Arsenic trioxide, caustic soda, and phenol (spray).
4. Phosphorus (yellow) injection.

Flowering very considerably Checked during 1913 in Plants Poisoned by—

1. Arsenic trioxide (spray).
2. Arsenic trioxide and hydrochloric acid (dilute and strong spray.)
3. Arsenic trioxide, caustic soda, and salt (injection and spray).
4. Arsenic trioxide, salt, and sulphuric acid (vapour).
5. Arsenic trioxide and washing soda (spray, dilute, and strong).

Flowering Checked to a fairly marked extent during 1913 in Plants Poisoned by—

1. Arsenic trioxide, caustic soda (spray).
2. Arsenic trioxide, caustic soda, and coal tar (dilute spray).
3. Arsenic trioxide, caustic soda, and potassium cyanide (injection).
4. Arsenic trioxide, caustic soda, salt, and prickly-pear juice (injection).
5. Arsenic trioxide, washing soda, and salt (liquid injection).
6. Copper sulphate (injection).
7. Ferrous sulphate (injection).
8. Hydrochloric acid (spray and gas charge).
9. Mercuric chloride (injection).
10. Mercuric oxycyanate (injection).
11. Phenol and methylated spirits (injection).
12. Potassium sulphocyanide (injection).
13. White lead in nitric acid (injection).

Flowering Checked to a slight extent during 1913 in Plants Poisoned by—

1. Arsenic trioxide, salt, and sulphuric acid (spray).
2. Arsenic trioxide, salt, sulphuric acid, and sodium bisulphite (spray).
3. Arsenic trioxide, washing soda (injection).
4. Barium chlorate (injection).

5. Carbon bisulphide and methylated spirits (spray).
6. Formaldehyde (injection).
7. Lead acetate (injection and strong spray).
8. Sulphuric acid (strong and dilute spray).
9. Xylol (spray).

Effect on the Germination of Seeds.—Whether any injurious influences, following on the application of chemical poisons to the plants, extend to the ripe seeds present in fruits of plants, which were treated at least three months before the flowering season, has not yet been determined.

The following experiment is in progress:—One hundred such seeds have been lately sown in a box containing sifted soil; beside this is a second box in which 100 ripe seeds extracted from fruits of normal unpoisoned plants were sown under similar conditions for use as a control. Up to the present date none of either set of seeds have germinated.

The effect of Poisons on the Segments of plants developed subsequently to the application of Poisons.—Almost without exception, segments produced subsequently to the application of poisons to the plants develop corky areas, which are scattered at varying distances apart over their surfaces. In a few instances a small proportion of these segments becomes so much affected as to cause their desiccation and death. The most marked effect has been observed in the subsequently developed segments of plants, which have been treated with potassium sulphocyanide, applied either in the form of injections or spray. The newly formed young segments are abortive at the tip and gradually wither down towards the base of the segment, though usually the destruction does not extend throughout the entire length of the segment. (Plates 2 and 3.)

The segments which are being formed at present exhibit this peculiar characteristic, even in one group of plants treated with this chemical as far back as 25th January, 1913.

In a few instances of plants treated with other poisons, the segments developed after poisoning do not appear to be affected, at all events externally, by the treatment to which the plants have been subjected.

Sprouting of Segments and Green Fruits which have become detached from Plants after Poisoning.—Only those plants are considered which have been poisoned with the specifics elsewhere enumerated as efficacious for pear destruction, and in which a fairly copious fall of segments and green fruits has occurred.

Where several plots have been treated with the same kind of poison in a similar manner, their average results are expressed, and only those plants which were subjected to the deleterious action of the specific more than three months prior to the present date are included in the table.

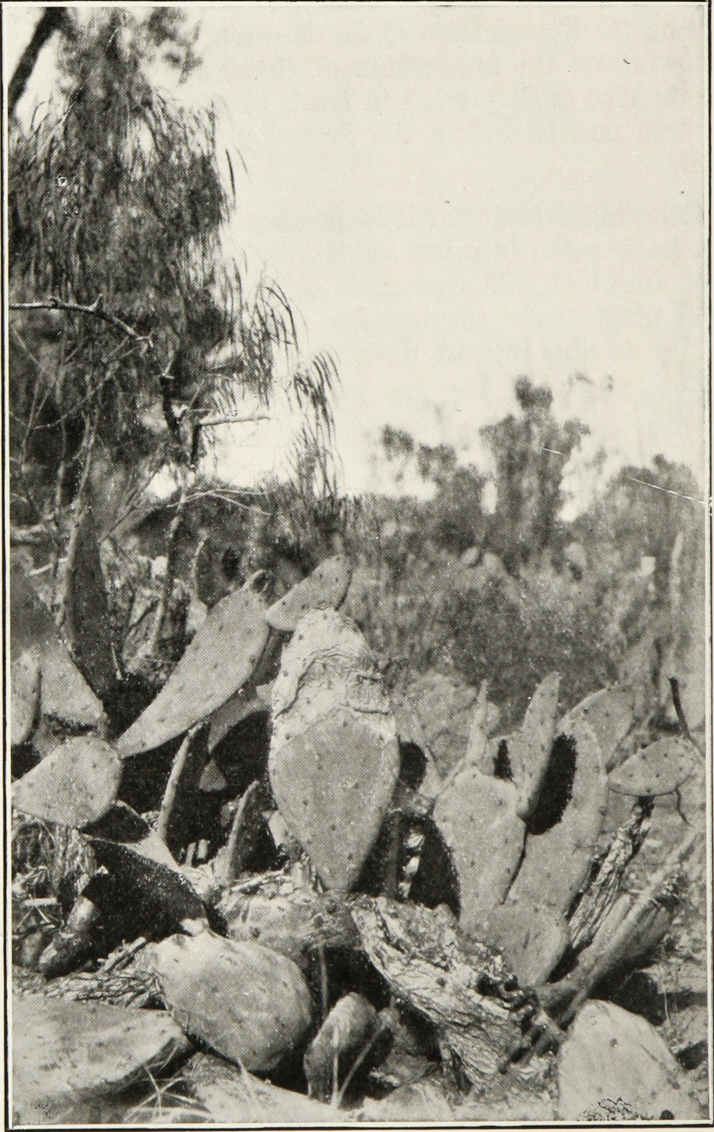


PLATE 2.—Plant of Dulacca Pear fifteen months after spraying with potassium sulphocyanide, showing the effect of the treatment on the recently produced segments.



PLATE 3.—Plant of Dulacca Pear which has been treated in the same manner as that in Plate 2.

The figures are approximate, and are only quoted where the percentage of growing "detached parts" does not exceed 50.

Poison Employed.	Mode of Application.	Approximate Percentage of Detached Segments and Green Fruits which have become Rooted.
Antimony chloride	Injection and spray ..	4
Arsenic pentoxide	Injection	4
Arsenic pentoxide	Spray	004
Arsenic sulphide and caustic soda ..	Injections	11
Arsenic trichloride	Vapour (under cover) ..	0
Arsenic trioxide	Vapour (under cover) ..	13
Arsenic trioxide and ammonium hydroxide ..	Injections	5
Arsenic trioxide and caustic soda ..	Spray	50
Arsenic trioxide and hydrochloric acid ..	Spray	50
Arsenic trioxide, caustic soda, and chloride of lime ..	Injections	25
Arsenic trioxide, caustic soda, and carbolic acid ..	Spray	50
Arsenic trioxide, caustic soda, and potassium cyanide ..	Injections	9
Arsenic trioxide, caustic soda, and salt ..	Injections	13
Arsenic trioxide, caustic soda, and salt-petre ..	Injections	7
Arsenic trioxide and salt	Spray	20
Arsenic trioxide, salt, and sulphuric acid ..	Vapour	10
Arsenic trioxide and washing soda ..	Injection and spray ..	20
Arsenic trioxide, washing soda, and salt ..	Injection and spray ..	20
Nickel sulphate	Injection and spray ..	50

INFLUENCE OF TEMPERATURE AND HUMIDITY ON THE DESTRUCTION OF PRICKLY PEAR BY POISONING.

The Experimental Station has been equipped by the Commonwealth Government as a Climatological Station, and accurate meteorological readings are recorded daily at 9 a.m.

During the year 1913 a special line of plots was reserved for the sole purpose of investigating the influences of climatological conditions on poisoning operations.*

The results obtained from weekly observations of the plots comprising this line are irregular, as is shown by the following statistics for the year 1913:—

Month.	Total Rainfall	Average Maximum Temperature. Fahr.	Average Minimum Temperature. Fahr.	Relative Effect of Poisons on Plots Treated during the Month.
	Points.	Degrees.	Degrees.	
January	173	91	67	Twelfth most affected.
February	220	92	67	Eleventh most affected.
March	291	92	54	Third most affected.
April	82	90	56	Eighth most affected.
May	176	74	46	Ninth most affected.
June	368	67	36	Most affected.
July	124	72	40	Second most affected.
August	0	70	35	Fifth most affected.
September	146	76	44	Fourth most affected.
October	182	85	52	Tenth most affected.
November	28	94	56	Sixth most affected.
December	326	93	63	Seventh most affected.

* Annual Report of Department of Public Lands, Queensland, for the year 1912, page 70.

The only general information gained by the above records is that the injurious action is more effectual when the poisons are applied during the colder, wetter months of the year. So many discrepancies, however, occur that the above readings cannot be considered as in any way final, and a similar series of experiments is being repeated this year. Last winter was an exceptional one regarding its rainfall.

In addition to the above table, observations were made regarding the influence exerted by rain occurring before and after the mechanical operations of poisoning prickly pear, consideration being confined only to the specifics exerting a noxious influence on the life of the pear. As in case of the last-described series of experiments, the results obtained are extremely variable, the only conclusion to which they lead being the general one, that rain falling within about thirty hours after poisoning has been accomplished reduces the efficacy of liquids sprayed on to the plants, but does not appear to materially affect the injurious action on injected plants.

Rain falling from five to twenty-one days after treatment appears to exert some slight beneficial influence so far as pear destruction is concerned.

EFFECT PRODUCED ON THE SOIL UNDER PLANTS SUBJECTED TO THE ACTION OF CHEMICAL SPECIFICS.

The operations at the Station are not sufficiently advanced for an adequate discussion of this effect. When the process of elimination of useless specifics has been completed, groups of three plots will be prepared and used for this investigation, which is a most important one from an economic standpoint.

The pear on one of these three plots will be treated with some poison which has been definitely proved to be efficient. The remaining two plots will be well protected against the access of any poison.

After a few months it is intended to clear all three plots of pear. The poisoned pear plants from the firstmentioned plot will be dug into the soil of one of the two latter plots, in order to test whether any deleterious effects will accrue from the use of poisoned pear as manure.

All three plots will then be sown with equal numbers of selected agricultural seed, as mentioned in my previous report.*

DESTRUCTION OF PRICKLY PEAR BY MEANS OF PARASITIC INSECTS.

Cochineal Insects.—A second consignment of wild-cochineal-infested segments of *Opuntia monacantha* was received at the Experimental Station from the Royal Gardens, Henaratgoda, Ceylon, on 5th July, 1913.

The segments were packed in a large wooden case amongst cocoanut fibre, and were held in place by means of wire netting. A small proportion of the insect masses was apparently alive, though the majority of the segments was decayed and rotting. On the same date another small wooden box containing wild-cochineal-infested segments of *Opuntia monacantha* arrived at the station from Wynberg, Cape Province, South Africa. Most of the segments were damp and in various stages of decay,

* Annual Report of Department of Public Lands, Queensland, for the year 1912, page 70.

and were more or less infested with mould fungi. A few insect masses were judged to be still alive. The totally decayed segments were removed and destroyed, and a large supply of fresh green *Opuntia monacantha* segments was placed in each box.

As a protection against ants, the boxes containing the infested segments were kept always surrounded by water. In his report from South Africa, the chairman of the Prickly-Pear Travelling Commission advised that the South African form was a distinct variety (*Coccus confusus capensis*—Green) from the Ceylon form (*Coccus indicus*—Green). Accordingly, the boxes containing these two varieties were kept perfectly isolated from each other.

By 30th July, 1913, those insects of the first consignment from Ceylon which had survived the voyage to Australia were reproducing well, and the young motile forms were passing on to the fresh segments of *Opuntia monacantha* supplied to them.

These insects have continued to multiply quickly, and their supply of new *Opuntia monacantha* segments has to be frequently replenished.

The cochineals of the second consignment from Ceylon had begun to multiply by 23rd September, 1913, but those from South Africa still remained inert, without exhibiting the slightest signs of increasing.

However, nearly all the insects were reproducing rapidly by 28th November, 1913. The male forms of *Coccus indicus* are small, measuring from about .761 mm. in length, and are provided with a pair of transparent wings. They appear to be short lived.

The adult female is much larger, measuring from about 2.5 to 3.5 mm. in length, and 1.6 to 2 mm. in breadth. It is wingless, and on reaching maturity becomes stationary on a segment of *Opuntia monacantha*, and invests itself with a white mealy tomentum. In this condition it lays eggs and dies, its body-wall forming a protective envelope for the eggs, which on being hatched give rise to small larval forms endowed with the power of locomotion. These move about till they usually find some suitable spot on an *Opuntia* segment, on which the females in their turn settle down. The length of time during which the larvæ retain their power of active movement, and the maximum distances over which they are capable of travelling, have not, so far, been calculated here, but that they are liable to pass over long distances relative to their size is illustrated by the following observations:—

A box of fresh *Opuntia monacantha* segments forwarded to the station by Mr. A. T. Clerk was placed under the laboratory, at a distance of at least 12 feet from the nearest box containing cochineal insects in the workshop. Within fourteen days the majority of segments present in the box had become infested with cochineals. This is a conclusive proof that the contiguity of prickly-pear plants is not necessary to permit of the spread of the insects from plant to plant. Close to the above-mentioned box of *Opuntia monacantha* segments, and nearer than it was to the boxes containing the infested segments in the workshop, was a quantity of a different species of prickly-pear from Gayndah—probably *Opuntia dillenii*. This pear was completely unattacked by the cochineals, which appear to be endowed with some instinct which guides them to the species *monacantha*.

Insect Tents.—The above observation indicates that it is futile to attempt to induce the cochineal insects to settle on most of the other species

of prickly pear, and on other genera of plants, if there happens to be any *Opuntia monacantha* available within their reach. On this account, all the three hessian tents described in my last report* were reserved solely as nurseries for the acclimatisation and propagation of *Coccus indicus*, each tent being furnished with a large supply of young *Opuntia monacantha* plants. (Plate 4.) A form of wild cochineal insect sent from



PLATE 4.—Interior of one of the *Coccus indicus* acclimatising tents, showing infested plants of *Opuntia monacantha*.

Ceylon on segments of a different kind of pear which appeared to be similar to our Emerald tree-pear did not become acclimatised and died out completely, but the reproduction of the *Coccus indicus* took place rapidly in the spring, as was mentioned before. The insects fed so voraciously that it was found necessary to plant, on an average, about twelve new plants of monacantha weekly in the tents.

* Annual Report of Department of Public Lands, Queensland, 1912, page 72.

None of the plants were in contact, but the larvæ evidently experienced no difficulty in passing from plant to plant.

In a few weeks after becoming heavily infested, the plants appeared to be quite dead, and not one of these presumably killed plants has exhibited the smallest sign of vitality since.

As *Opuntia monacantha* does not occur naturally near Dulacca, I am dependent for a supply of these plants on "cuttings" forwarded from other parts of the State by Mr. A. T. Clerk. These are struck at the Experimental Station, and are small when moved into the breeding tents, so that it is quite possible that, while these young plants become completely destroyed through the agency of the insects, the effect might not be so drastic on the old tough plants, such as prove a pest in parts of Northern Queensland.

In order to ascertain whether this will prove to be the case, I intend to take a trip shortly to some of the *Opuntia monacantha* infested districts, and endeavour to establish the wild cochineal insects among the large plants growing there. Whether the destruction of the plants is caused by a toxic action exerted by the insects, or is simply due to the extraction by them of all the nutrient matter from the plants, is not, so far as I can ascertain, known. The length of time occupied for the analysis of the pear segments and stems which have been totally or partially destroyed by the cochineals, for the possible detection of injurious toxines, would be very considerable, and the chance of ultimate success is too small to render such an investigation desirable.

In spite of extremely strict precautions, a small variety of ant (*Iridomyrmex* sp.) and one of the Coleoptera (*Laius vellulus*)† managed to effect an entrance into the breeding tents during December, 1913. As these could not be got rid of by the application of poisons, on account of the possible danger to the cochineal insects, the tedious process of eliminating the pest by mechanical means had to be resorted to. This work involved the expenditure of from two to four hours daily for a period extending over six weeks, after which time they had all been successfully excluded from the tents, which have since been free from any insects which might be parasitic on the cochineals.

PROPAGATION OF *COCCUS INDICUS* ON THE DIFFERENT SPECIES OF PEARS OCCURRING IN QUEENSLAND.

When the number of wild cochineal insects had increased sufficiently to justify the possible risk involved of losing a few hundreds, preparations were made to afford the insects every opportunity for attacking other kinds of prickly pears which occur in Queensland, more especially those which prove a pest to the State. For this purpose seven hessian tents were erected in the station reserve, similar in structure to the previously

† These insects were kindly identified by Mr. C. French, of Melbourne.

described acclimatisation tents. These were isolated from each other by a minimum distance of 90 yards. They were not surrounded by a drain containing poisoned water, but the ground extending over an area of 2 yards round each tent was sprayed with a strong solution of potassium cyanide, the soil in the interior of the tents being treated in a similar manner.

The earth inside the tents was well dug up, and a different species of prickly pear was planted in each. As most of these plants have not flowered at the station yet, it is not possible to name them all with certainty.

On to the segments of *Opuntia monacantha* in one tent masses of *Coccus confusus capensis* were put. This insect, according to the report of the Prickly-Pear Travelling Commission, is not so noxious to the *Opuntia monacantha* in South Africa as is the *Coccus indicus* to the same species of pear in Ceylon. Whether the latter variety of insect will cause greater havoc amongst the *Opuntia monacantha* plants growing in Queensland than the former variety has not yet been determined, as the *O. monacantha* to which the former variety of cochineal was attached is only now becoming heavily infested.

On to the segments of all the other species of pear, masses of *Coccus indicus* from Ceylon were placed, and the behaviour of the insects is watched and noted at weekly intervals.

Up to the present time a fairly large number of motile forms has passed on to the segments of all the different pear species in the tents. The insects have settled down on these plants, but with the exceptions of those on *Opuntia monacantha* and Emerald tree-pear they exhibit no sign of vitality, or of the formation of a tomentum, and are almost certainly dead. The segments of *Opuntia monacantha* are becoming rapidly, and those of Emerald tree-pear slowly, infested with apparently healthy cocci, in some of which the process of reproduction has already begun.

PREFERENCE OF COCHINEAL FOR SOME SPECIES OF PRICKLY PEAR.

The question as to why the cochineals prefer some species of cactus rather than others has received some consideration, and is still under investigation.

The segments and fruits of most of the species of pear dealt with at the station have been analysed by the Government Agricultural Chemist of this State. The report of most of his analyses is published in the "Queensland Agricultural Journal" of July, 1913, from which the greater part of the following statistics has been copied:—

ANALYSES OF PRICKLY PEAR.

GREEN PLANT.

Variety.	Moisture.	Total Dry Matter.	Crude Ash.	Proteins = N x 6.25.	Crude Fat.	Fibre (König).	Fibre (acid- alkali).	Pentosans.	Water Soluble.	Alcohol Ppt. (Galactan).	Water Solu- ble Ash.	Total Sugars (as Dextrose).	Water Soluble Nitrogen.	Total Nitrogen.	Protein Nitrogen.
Spiny Pear, Gayndah ..	81.80	18.20	1.65	.83	.10	1.72	1.65	2.95	7.81	3.04	1.27	2.00	.076	.153	.133
Dulacca Pear ..	89.70	10.30	1.58	.39	.12	.91	1.05	1.56	5.82	1.50	1.22	.64	.038	.083	.062
Giant Red Mexican, Westwood ..	91.50	8.50	2.65	.37	.09	1.47	2.06	.59	4.58	1.66	1.06	.50	.033	.076	.059
Emerald Tree-pear ..	89.50	10.50	1.80	.47	.07	1.01	1.06	1.02	3.88	1.11	.83	.76	.021	.091	.076
Helidon Tree-pear ..	93.80	6.20	1.94	.28	.10	.76	.81	.33	2.73	.68	.84	Nil	.039	.053	.045
Giant Mexican Spineless Variety (Brisbane, 1906)	94.37	5.63	1.53	..	..	..	.80	.66	2.36	..	.96	.38	.047	.079	..
Dulacca Pear (normal growth, 1912) ..	86.3	13.7	1.49	..	..	..	..	..	..	..	..	..	..	.051	..
Dulacca Pear (abnormal growth) ..	81.1	18.9	1.23	..	..	..	..	..	..	..	..	..	..	.058	..

AIR DRY PLANT.

Variety.	Moisture.	Total Dry Matter.	Crude Ash.	Proteins = N x 6.25.	Crude Fat.	Fibre (König).	Fibre (acid- alkali).	Pentosans.	Water Soluble.	Alcohol Ppt. (Galactan).	Water Solu- ble Ash.	Total Sugars (as Dextrose).	Water Soluble Nitrogen.	Total Nitrogen.	Protein Nitrogen.
Spiny Pear, Gayndah ..	7.90	92.10	8.36	4.22	.54	8.72	8.35	14.92	39.50	15.40	6.43	10.11	.385	.774	.674
Dulacca Pear ..	7.50	92.50	14.29	3.52	1.11	8.13	9.42	14.09	52.40	13.47	10.95	5.74	.341	.745	.562
Giant Red Mexican, Westwood ..	3.75	96.25	29.99	4.23	1.00	16.0	22.46	6.44	49.80	18.80	11.55	5.45	.360	.858	.675
Emerald Tree-pear ..	3.53	96.47	16.57	4.39	.75	9.29	9.78	9.41	35.65	10.20	7.62	6.98	.193	.842	.702
Helidon Tree-pear ..	3.58	96.42	30.31	4.39	1.58	11.82	12.60	5.20	42.46	10.57	13.62	Nil	.609	.829	.702
Giant Mexican Spineless Variety (Brisbane, 1906)	..	100.00	27.2	..	..	..	14.15	..	41.9	..	17.1	6.7	.83	1.41	..
Dulacca Pear (normal growth, 1912) ..	..	100.00	11.10	..	..	..	..	..	..	..	..	..	..	.382	..
Dulacca Pear (abnormal growth) ..	..	100.00	6.69	..	..	..	..	..	..	..	..	..	..	.315	..

ANALYSES OF PRICKLY PEAR FRUIT.

Variety.	Seed.	Peel.	Edible Portion.	COMPOSITION OF EDIBLE PORTION.														
				Total Solids.	Soluble Solids.	Protein = N x 6.25.	Acidity of Juice (as H ₂ SO ₄).	POLARISATIONS.					Total Sugars (as Dextrose).	Total Ash.	Soluble Ash.		Alkalinity of Sol. Ash. (as K ₂ CO ₃).	Alcohol Ppt. (Galactan).
								Direct.	Inverted.	Temperature.	Sucrose by Polarisation.	Sucrose by Reduction.						
Spiny Pear	11.0	19.6	69.4	10.45	7.98	.662	1.41	+ .13	- 1.5	28° C.	2.15	1.93	2.29	1.05	1.00	.304	.70	(1) Fruit uniformly red to epidermis. Taste sharply acid. Mucilaginous.
Dulacca Pear	..	26.5	73.5	12.40	9.54	.316	.85	- 2.5	- 2.5	26° C.	Nil	.36	5.66	1.50	1.37	.635	.50	(2) The best sample of those examined. Fruit red-coloured to epidermis. Taste sweet and not over acid. Mucilaginous.
Giant Red Mexican	6.0	23.4	70.6	9.30	6.94	.265	.32	+ .8	- .4	26.5° C.	.91	.52	3.55	..	.76	.550	.68	(3) Fruit red-coloured. Taste sweet, insipid and mucilaginous.
Emerald Tree Pear																		(4) Fruit small and inedible.
Helidon Tree-pear																		

(5) only few fruit received. Green in colour; flesh red; taste insipid. Probably very low percentage of sugar and acidity.

Analysis of Prickly-pear (*Opuntia monacantha*) received from A. Temple Clerk, and analysed for Dulacca Experimental Station by the Agricultural Chemist, Brisbane:—

—						Green Material.	Dry Material.
Moisture	..	..	..	..	..	80.40	3.70
Total dry matter	..	..	..	..	..	19.60	96.30
Crude ash	..	..	..	..	..	2.45	12.00
Containing lime	..	..	..	..	..	.698	3.43
Magnesia	..	..	..	..	..	.270	1.32
Potash	..	..	..	..	..	.921	4.53
Phosphoric acid	..	..	..	..	..	.065	.32
Crude fat	..	..	..	..	..	.24	1.20
Proteins (N x 6.25)	..	..	..	..	..	.52	2.55
Fibre (König)	..	..	..	..	..	2.28	11.20
Fibre (acid-alkali)	..	..	..	..	..	2.68	13.16
Pentosans	..	..	..	..	..	.98	4.83
Water soluble	..	..	..	..	..	8.00	39.30
Alcohol ppt. (Galactan)	..	..	..	..	..	1.58	7.76
Water soluble ash	..	..	..	..	..	.46	2.26
Total sugars (as Dextrose)	..	..	..	..	..	1.39	6.83
Water soluble nitrogen	..	..	..	..	..	.073	.360
Total nitrogen	..	..	..	..	..	.114	.560
Protein nitrogen	..	..	..	..	..	.083	.408

O. monacantha lies about midway in composition between the spiny pear of Gayndah and the common Dulacca pear, and is therefore more nutritious than Dulacca pear.

The last statement may possibly have some bearing on the question under consideration, but it is more probable that the marked preference displayed by the cochineals for certain species of pear is due to a mechanical rather than a chemical difference exhibited by the plants.

Accordingly, sections were prepared of the external skin from the segments of every kind of pear enumerated above, the segments selected for this purpose from each species being as nearly similar in size and texture as it was possible to obtain.

Microscopic examination shows that the most superficial portion of the skin is composed of several layers of small, somewhat irregularly shaped cells, possessing thickened walls, the outermost row of cells being bounded externally by a structureless cuticle of varying thickness.

The width of the cuticles and collenchymatous tissues present in the different species of pear examined are as follows:—

Species of Pear.					Width of Cuticle.	Width of Collenchymatous Tissue.
Emerald Tree Pear	..	..	..	..	.005 mm.	.. .14 mm.
Spiny Pear of Roma	..	..	..	..	.02 mm.	.. .20 mm.
Spiny Pear of Gayndah	..	..	..	..	.013 mm.	.. .26 mm.
Dulacca Pear	..	..	..	..	.014 mm.	.. .22 mm.
<i>Opuntia monacantha</i>	..	..	..	..	.010 mm.	.. .16 mm.
Helidon Tree Pear	..	..	..	..	.006 mm.	.. .18 mm.
Yellow Mexican	..	..	..	..	indefinite	.. { .14 mm.
					and hairy	.. { exclusive of hairs
Red Mexican	..	..	..	..	indefinite	.. { .20 mm.
					and hairy	.. { exclusive of hairs

From the above table it may be seen that the minimum amount of collenchymatous tissue is possessed by the Emerald tree-pear and Yellow Mexican. *Opuntia monacantha* comes next in this respect, and is followed in order by Helidon tree-pear, Spiny pear of Roma, Red Mexican, Dulacca pear, and Spiny pear of Gayndah.

Reference to the preceding section of this report shows that the species of pear which are preyed on by the wild cochineal insects are those in which there is the smallest development of thick-walled tissue. Consequently, the deposition of cutin and other strengthening materials in the cell walls probably plays an important part in the investigation of the ability of the insects to extract nutriment from the internal cells of the different kinds of pear. The epidermis of the Helidon tree-pear and the two varieties locally known as Mexican is plentifully provided with hairs which are apparently of use in enabling the plant to withstand the attacks of the insects.

AGRICULTURAL PLOTS, ETC.

Although all the available evidence indicates that these insects have never been known to attack other plants in countries where they are found, and are extremely unlikely to do so in Australia, I have considered it advisable to carry out the following experiments:—

Plots were cleared in isolated positions in the experimental reserve, and sown with seeds of some of the common agricultural plants, viz.:—Maize, potatoes, pumpkins, rock melons, tomatoes, water melons.

During February and March, 1914, excised portions of wild-cochineal-infested segments of *Opuntia monacantha* were attached to the leaves of these young plants. The active larval forms very quickly moved on to the plants, but, so far, in no instance have they attained maturity, their bodies becoming shrivelled and dried.

Masses of *Coccus indicus* have recently been applied to ripe fruits of tomatoes and apples with the object of ascertaining whether the latter might be able to extract food material from these fruits. Though it is yet too early to make any definite statement as to the probable results, the progress attained so far indicates that the insects will be unable to accustom themselves to this class of food, and the possible chance of injury to the ripe fruits through their agency is very remote.

DESTRUCTION OF PRICKLY PEAR BY OTHER METHODS.

In December, 1913, Mr. Torbock, Crown lands ranger stationed at Taroom, reported to the Department that in certain localities a bush locally known as the Coughing or Snuff Bush occurs profusely, and that the pear will not grow in these scrubs.

In order to investigate this plant, I visited Taroom during April, 1914, and observed plenty of the Snuff Bush flourishing about Lilyvale Estate. In many places it was seen growing alongside and amongst the pear, and in localities thickly infested with the bush young pear plants were noticed springing up wherever there was the smallest available space. Mr. Torbock, however, still retains his opinion that some detrimental action is exerted on the pear by the Snuff Bush in some parts of the district. He has undertaken to collect samples of soil from the localities he mentioned, and to forward them to me for analysis.

Young plants of Coughing Bush were brought from Lilyvale Station, and have been planted among the pear in specially prepared plots at the Experimental Station.

Attention has also been called to the presence of maggots of different kinds of insects on certain pear segments and trunks which have become rotter through some agency. These have, in all probability, been hatched from eggs deposited in the already decayed tissue. The occurrence of these maggots has been commented upon by the Government Entomologist of Queensland.*

THE OCCURRENCE OF FUNGI ON PRICKLY-PEAR PLANTS.

Specimens of apparently diseased pear segments have been received at the station from several localities in the pear-infested districts of Queensland.

In no instance has any injurious form of parasitic organism been discovered, but, as a rule, fungi have been present, which on investigation have proved to be some forms of saprophyte.

Of special interest are two fungal forms frequently found on those parts of prickly-pear plants which have been destroyed by poisons. Specimens of these two fungi were forwarded to the Royal Botanical Gardens, Kew, and have been identified thus:—

1. *Rhinotrichum pulchrum*, Berk.—This forms an orange-coloured powdery mass which specially seems to select for its host pear killed by some form of arsenical poison. It is possible that it may accelerate the injurious action exerted by the poison, but does not appear to itself produce any direct noxious effect on the pear plants.

2. *Schizophyllum commune*.—This fungus is pale grey in colour, and possesses radiating lamellae on its under surface. It is described by Massee in "The Diseases of Cultivated Plants and Trees," page 359, from which the following extract is copied:—

"It is said to be parasitic on the sugar-cane in the West Indies. It has also been recorded as doing injury to the horse-chestnut and mulberry in France."

Though the fungus is of very frequent occurrence on *Dulacca* pear, it does not seem to exercise any appreciable deleterious effect on this plant. (Plate 5.)

REPRODUCTION OF DULACCA PEAR.

This subject has been referred to already under the heading "The effect of poisons on the segments of plants developed subsequently to the application of the poisons."

Vegetative Reproduction.—An experimental plot was prepared in November, 1912, for the purpose of testing the reproductive powers of different parts of the plants of *Dulacca* pear. The results furnished from the observation of this plot up till 30th June, 1913, were enumerated in my previous report.†

* Report on "an instance of reported prickly-pear destruction by insect agency in the Roma district," 11th October, 1911.

† Annual Report of Department of Public Lands, Queensland, 1912, page 77.

Healthy vigorous young plants have developed from the following "cuttings":—

Abnormal flowers.

Normal green fruits.

Abnormal green fruits.

Normal young and medium-aged segments.

Abnormal young and medium-aged segments.

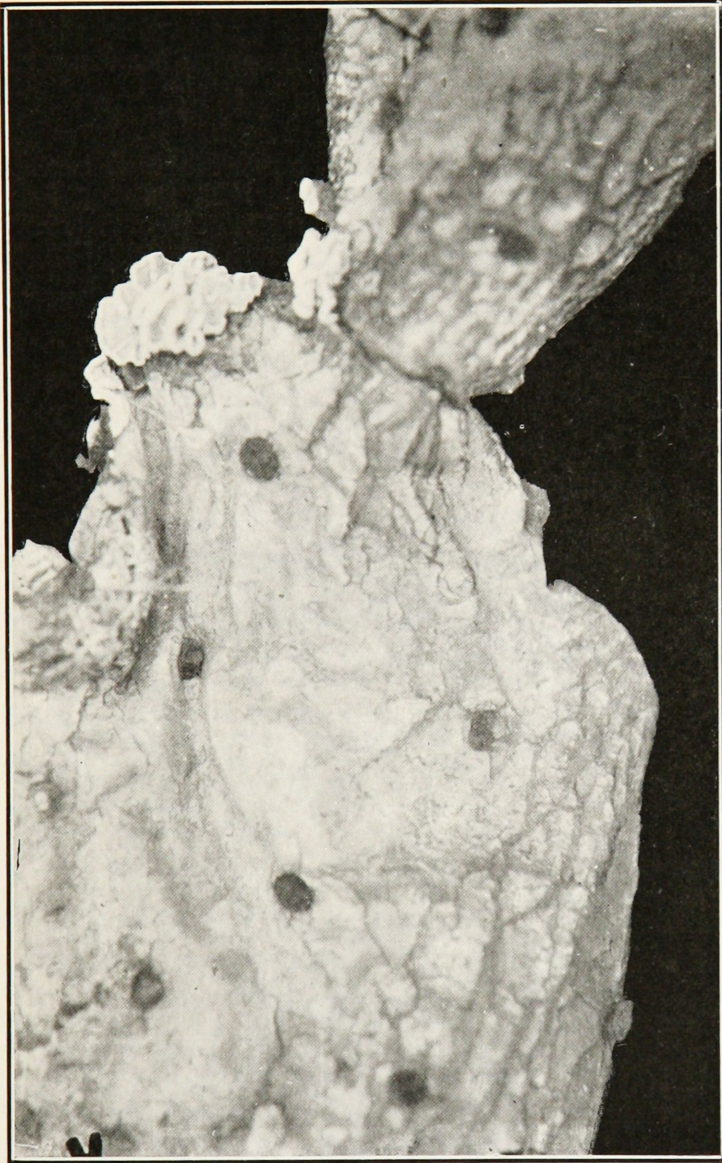


PLATE 5.—Segments of Dulacca Pear attacked by a fungus (*Schizophyllum commune*).

In addition, young plants have sprung from a small excised portion of a "bulb" planted in May, 1913, and also from a segment removed from an arsenic-poisoned plant, whose nodes had been apparently destroyed by the poison, which was planted on the same day.

The following list comprises those "cuttings" which completely died out after being planted in the reproduction plot:—

Normal flowers.

Normal ripe fruits.

Abnormal ripe fruits.

Normal old segments.

Abnormal old segments.

Newly formed segments.

Isolated nodes (surrounded by a small quantity of green tissue) cut out from a normal healthy medium-aged segment.

Excised portions of roots.

Sexual Reproduction.—The process of germination of the seeds of the *Dulacca* pear is apparently very slow, and, judging from all the experiments carried on here, only a small proportion of the seeds actually germinate. One hundred seeds were extracted from ripe fruits in good condition, and were sown in separate boxes containing carefully sifted soil, on each of the following dates:—

28th May, 1913 (50 seeds sown).

12th July, 1913.

23rd September, 1913.

20th January, 1914.

17th February, 1914.

1st April, 1914.

The boxes were placed in rather an exposed position, and watered during dry weather.

Of the seeds sown on 23rd September, 1913, two germinated about 22nd January, 1914, and a third seedling was observed in the same box one day later. By 2nd February these seedlings had all withered and completely disappeared. Two more seeds in the same box germinated on 28th March, 1914. These are watered carefully and are protected by an ordinary flower-pot from the powerful rays of the sun during the hottest part of the day.

The reason why the few seeds which germinated should be amongst those sown on the one date is not known. It may be that these particular seeds were of superior quality, or that the soil put into that special box was better suited to assist in bringing about the germination of the seeds.

It seems most probable that the greater number of seedlings produced is short lived, and only those develop into adult plants which during their early life history happen to be situated in some protected position, such as underneath the parent plant, or are subjected to other specially favourable conditions.

The experiments performed at this station indicate that vegetative reproduction is the principal factor in effecting the spread of the *Dulacca* pear, the germination of the seeds being of minor importance in this respect.

ABNORMAL AND NORMAL PEAR.

Effect of Burning on Normal Pear.—The cause of the abnormality which was discussed at some length in my last report* is still undetermined.

* Annual Report of Department of Public Lands, Queensland, 1912, pages 73 and 74.

The normal plants which had been severely burnt on 18th November, 1912, were in full bloom in November, 1913. The average number of flowers was produced, and these were well developed and normal, and contained to all appearances normal ovules. The same plants were again burnt completely to the ground during November, 1913, and any effect produced on their flowers, following on their second burning, during the next season will be noted.

Effect of Frosts on Normal Pear.—Six normal healthy plants of Dulacca pear, situated in an exposed position, were marked in June, 1913. During the ensuing winter, several heavy frosts were experienced—viz., one in July, nine in August (on one occasion the temperature fell to 24.5 deg. Fahr.), and one in September. At the beginning of November all the plants were flowering, every bloom being normal. The only appreciable effect caused by frost was the development of corky layers over the exterior of most of the segments in two out of the six marked plants.

UTILISATION OF PRICKLY PEAR.

Manufacture of Alcohol.—Mr. F. H. Campbell, of Melbourne University, has investigated the value of prickly pear as a source for the production of alcohol. The results of his investigation are published in the "Report of the Australasian Association for the Advancement of Science," Melbourne, 1913, Vol. XIV. Mr. Campbell concludes that from a commercial standpoint the production of alcohol would be of little value. He says: "It is found that the value of the products per ton of green plant is approximately 8s. It is considered extremely doubtful that this would cover the cost of clearing the ground."

Extraction of Oil from the Seeds of Dulacca Pear.—Messrs. F. Smith and L. A. Meston have estimated the oil content of the seeds of the Dulacca pear. The results of their experiments are set out in a paper read before the Royal Society of Queensland in April, 1914.

Extraction of Potash.—Experiments dealing with the process of potash extraction from the ash of the pear have been performed by Mr. O. C. Roberts, managing director of the Cactus Estates, Limited. His results are expressed in the "Daily Mail," Brisbane, of 11th December, 1913.

During the year valuable assistance has been rendered by the following departments and institutions:—Agricultural Department of Queensland and Victoria; Analyst's Department of Queensland; Lands Department of Queensland; Leichhardt Rabbit Board; Royal Botanic Gardens, Kew; Universities of Queensland and Victoria; various agricultural departments of the world; also by Mr. Victor Leggo (Victoria), who presented samples of highly soluble arsenic; Mr. O. C. Roberts (Dulacca), who granted the use of portions of his freehold for the purpose of experimenting with insect parasites; Professor Baldwin Spencer (Victoria), who forwarded a loan collection of valuable books.

I have, &c.,

JEAN WHITE,

Officer in Charge of the

Prickly-Pear Experimental Station,

Dulacca.

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